ILLUSIONISM IN ARCHITECTURE

ANAMORPHOSIS, TROMPE L'OEIL AND OTHER ILLUSIONARY TECHNIQUES FROM THE ITALIAN RENAISSANCE TO TODAY

2008

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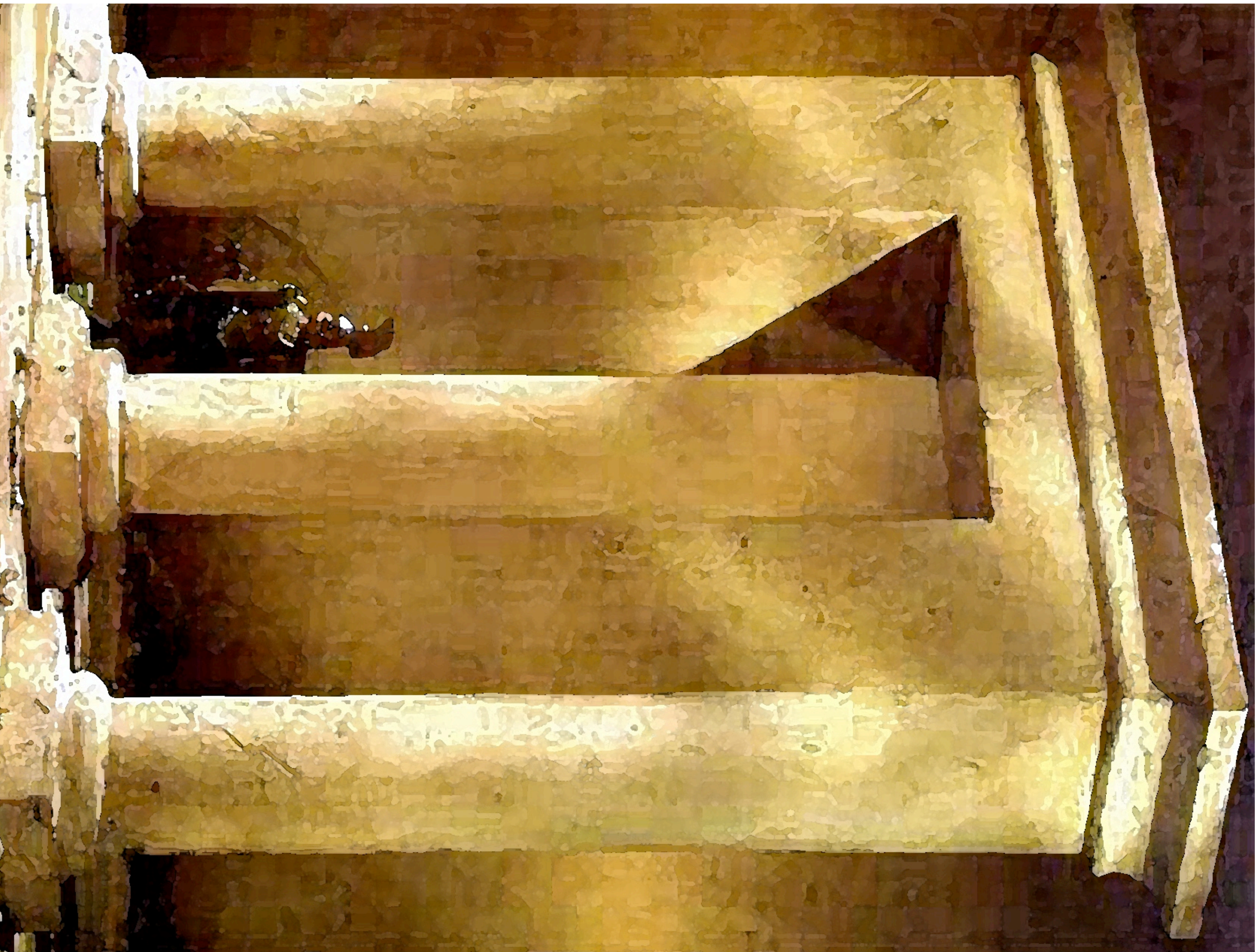

A dissertation submitted to the
Manchester School of Architecture
for the degree of Bachelor of Architecture

DECLARATION

No portion of the work referred to in the dissertation has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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I would like to express my gratitude and thanks to all
those who have encouraged and supported me
in the course of preparing this dissertation;
to Elysse Knight, my tutors Sally Stone
and Eamon Canniffe, and particularly to my
supervisor, Dr. Andrew Crompton
for his direction and encouragement

C O N T E N T S

A B S T R A C T

Optical illusions have appealed to the mind of spectators throughout history, and have had great impact when combined with architectural elements. Illusionary methods have been used by artists and architects since antiquity, but only during the Renaissance were they scientifically analysed to produce the techniques of perspective, anamorphosis, and their integration with trompe l'oeil. This paper is a study of these methods employed by artists and architects, focusing on the invention and evolution of the technique of anamorphosis from its birth during the Italian Renaissance. By analysing a compilation of early and contemporary cases of architectural illusionism in two and three dimensions, the methods used to manipulate observers' perceptions are explored in detail. By reintroducing these techniques of the past into contemporary practice they can prove very beneficial by producing enhancing spaces when spatial or economic restraints must be overcome.

INTRODUCTION

Sensing and seeing are not automatic processes but depend on cognitive processes that have been studied by scientists since the time of Descartes. Vision, the most essential sense possessed by artists and architects, is vital to turn conceptual forms into reality, or as Marleau-Ponty suggests 'vision is the brain's way of touching'. [1] 'It is physically accomplished by stimulating the retina of the eye with elements of light, colour, intensity and direction, combined with cognitive analysis of the sensory information. Along with elements of our own knowledge, background, and experiences, vision aids our understanding of our environment. [2, 3] Massey refers to Descartes and his work 'Discourse' : "The sense of sight gives no less assurance of the reality of its objects than do the senses of smell and hearing, while neither our imagination nor our senses could ever assure us of anything without the intervention of our intellect." [4]

As Luckiesh suggests: 'Seeing is deceiving'. [3] Our senses can be easily deceived and persuade us of irrational concepts, as the mind assimilates conflicting sensory information. [4] Sir Charles Sherrington explains that 'the brain is an enchanted loom, where millions of flashing shuttles weave a dissolving pattern, always a meaningful pattern though never an abiding one.' [2] We are presented with a constant battle, where what we may see is not always what we may know to be true. [5]

An illusion is 'something that deceives or misleads intellectually; perception of something objectively existing in such a way as to cause misinterpretation of its actual nature.' [6] Illusions are often perceived to be supernatural or magical phenomena, as they do not adhere to commonly experienced circumstances. Their practice used to be associated mostly with conjurers, magicians, illusionists, who entertain an audience with visual and mental deception techniques, including disorientation, misdirection, optical illusions, mechanical props and staging, and physical dexterity; as 'magic is but the power to control one's perception of events – now you see it, now you don't '. [1, 7] Illusions have also been used in the art of camouflage during the wars to deceive the enemy by masking the appearance of soldiers, vehicles, and structures. Artists and architects either take advantage of them, or avoid their use completely. [1, 3]

Optical illusions seem to have sparked great interest throughout history, as they call into question our perception of the physical world. [8] Purkinje states that 'illusions of the senses tell us the truth about

perception'. [1] In most cases illusions have no significant place, but in others they can play a vital role assisting in interpreting our surroundings, as 'the mental being is impressed with things as perceived, not with things as they are.' [3]

They create a momentary or persistent state of doubt. Massey discusses Harries, who describes doubt to being 'tied to possibility. In order to doubt we must be able to conceive of the possibility that something may be different from the way it presents itself to us. Essential to doubt is the contrast between what is and what appears to be'. [4, 9]

This exemplifies that 'all our perception is illusion' [8] expressing that the 'visual impressions' our mind creates from the information being received are based on our visual analysis and experience, and if it were to interpret the signals in a different manner, our world we are familiar with would seem foreign [2, 8] :

If the Creator were to bestow a new set of senses upon us, or slightly remodel the present ones, leaving all the rest of nature unchanged, we should never doubt we were in another world, and so in strict reality we should be, just as if all the world besides our senses were changed.
- John Muir [2]

AIM OF DISSERTATION

This paper is a study of illusionary methods employed by artists and architects, focusing on the invention and evolution of the technique of anamorphosis from its birth during the Italian Renaissance. My analysis will involve examining known methods of illusions utilised in architecture, the development of linear and anamorphic perspective, and the link between the practice of the two techniques. In this study I present a compilation of prime cases of architectural illusionism based on these systems, and analyse a number of them in two and three dimensions. Through researching journals, books, electronic resources, and immediate personal experience from visits to a number of significant locations, I hope to achieve a greater understanding of the commonly overlooked and undervalued subject of distortional perspective, anamorphic drawings, sculptures, and structures.

Throughout history illusions have been used to deceive, entertain, conceal, overcome spatial and economic restraints, and even heal the psyche. The benefit of such a study is to provide an insight into the process and methods used by pioneers of illusionary techniques, which were used in architectural structures and spaces.

Comprehensive studies on anamorphosis and similar illusions in architecture have been limited to the early developers and a number of artists since the Renaissance. Bramante, Borromini, Bernini, and Leonardo da Vinci were of the first who studied perspective and its potential for illusionism, [10] while Niceron [11] in the 17th centrury published extensively on the subject. In the 20th century, Luckiesh [3] and Seckel [12] explored numerous optical and spatial illusions, while Baltrusaitis [13] studied anamorphic art in great detail, along with Salgado [14], and Kent [15]. Leeman's research involved illusions in architecture in addition to anamorphosis, [10] whereas Collins [7] and Massey [4] analysed more of the perceptional studies on anamorphosis.

The range and variety of illusions in art and architecture are discussed using both historical and contemporary examples, as well as diagrammatical artwork, while particular emphasis is placed upon anamorphosis and its application in the course of the Italian Renaissance. An exploration of the technique of catoptric anamorphosis does not advance the aims of this study, as they were used primarily after the Italian Renaissance, commonly small in scale, and would require a study dedicated to them entirely; therefore they will be omitted.

The paper begins with the introduction of general illusions used in architecture since antiquity, followed by the exploration of perspective and its establishment as a universal artistic technique. It continues with the illustration of the art of trompe l'oeil and illusionism, together with the basics of the technique of anamorphosis, while a study of the Renaissance period and the early developers of linear perspective leads to an investigation of the evolution of anamorphic art and trompe l'oeil, and their application in architecture. An in-depth examination of some pivotal examples of illusionistic architecture precedes a final exploration into contemporary practice.

ILLUSIONS IN ARCHITECTURE

Illusions have been practiced in architecture since antiquity. Impressions of space and structure can be controlled by altering 'proportions and appearance' of building elements, as architects and designers have achieved for thousands of years, creating illusions of symmetry, scale, distance, 'weightlessness', and even 'dematerialisation' of the visual planes. Ruskin notes that 'all architecture proposes an effect on the human mind, not merely a service to the human frame', suggesting that it attempts to influence our impressions and stimulate the senses, not purely protect us from the elements. [1]

ILLUSION OF SCALE

The illusion of scale was a technique utilised in the Library of Celsus *(Fig. 1)*, circa 135 AD, in the Roman city of Ephesus (Asia Minor). In a limited area amid existing buildings, the building appears to be enormous. The twenty-one metres wide marble-paved courtyard leads to the two-storey gallery, which rests at the top of nine wide marble steps. Pairs of columns on the two levels support pediments of curved and triangular form, though the central columns' capitals and rafters are much larger than the others', creating the illusion of increased space between the columns. Along with the sloping edges of the podiums, the size of the central doorway reinforces the illusion by being taller and wider than the adjacent ones. [1, 16]

Fig. 1 - Library of Celsus, Ephesos, (Asia Minor) [16]

ILLUSION OF 'WEIGHTLESSNESS'

Architectural elements are able to appear suspended in space despite their massive structure, in some key instances in history. In Istanbul, Turkey, the church of Hagia Sophia *(Fig. 2)*, built by Isidoros and Anthemios, circa 535, is a Byzantine church, later used as an Ottoman mosque, and is currently serving as a museum. Its enormous dome appears to 'rest lightly on the lower structure' from within, suspended 'weightless' above the vast volume, though hidden piers provide the necessary support. [1, 17, 18]

Fig. 2 - Interior view of Hagia Sophia, Istanbul (Turkey) [18]

Gothic churches present a similar effect, where monumental 'external "flying buttresses"' were used to sustain the weight of the roof, while remaining hidden from observers inside, thus producing the effect of lightness. [1] The Cathedral at Coutances*(Fig. 3,4)* is a classic example:

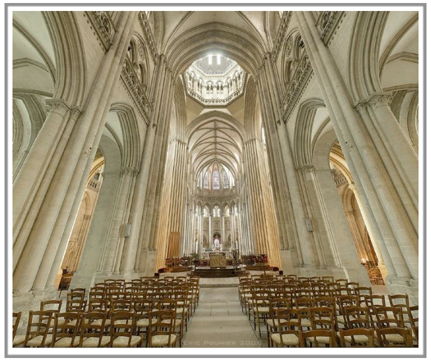


Fig. 3 - Interior view of the Cathedral at Coutances [19]

Fig. 4 - Exterior view of Cathedral at Coutances [20]

ILLUSION OF 'PLANE DEMATERIALISATION'

Mediterranean and Eastern cultures have exhibited 'patterned optical illusions' on floors of tiles or woodwork, which seem to deconstruct the flat floor plane and create additional illusory ones. Examples have been found in a number of countries including Japan, China, India, Persia, and Italy. [1]

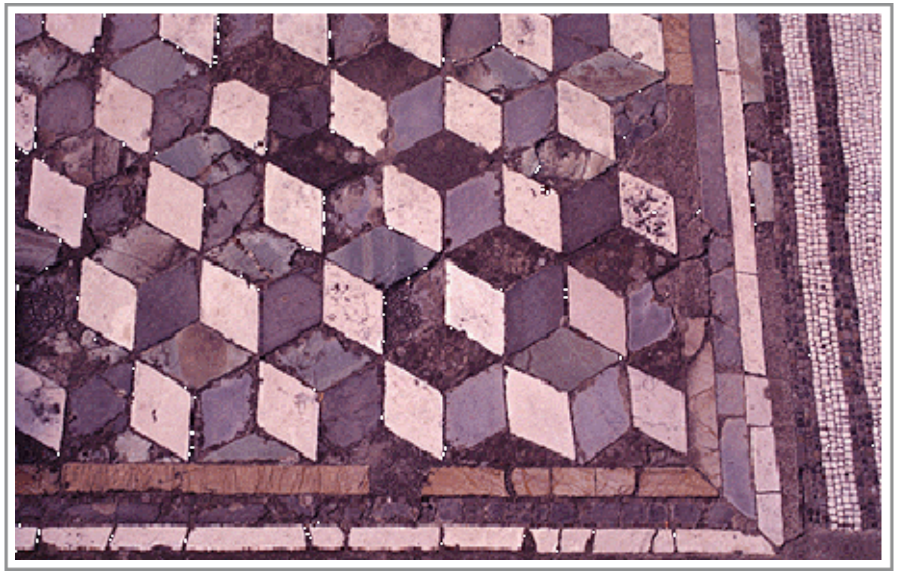


Fig. 5 - Tiled pavement, Pompeii (Italy) [16]

Fig. 6 - Tiled floor in the Scuola Grande di S. Giovanni Evangelista, Venice (Italy) *(photo taken by author)*

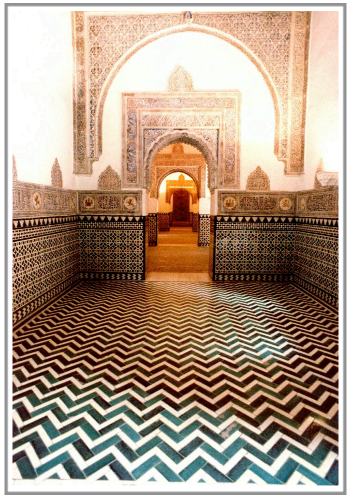


Fig. 7 - Mosaic Tile patterned floor at Alcazar, Seville (Spain) [21]

ILLUSION OF 'SHAKKEI'

'Shakkei', or 'borrowed landscape', is a technique of spatial illusion used mainly in traditional Japanese gardens, where certain selected distant views of surrounding landscape are 'reflected' in the space. An illusion of an uninterrupted and extensive garden area is achieved by positioning architectural elements at determined points in space, along with 'visual foreshortening of the foreground', and framing faraway landmarks with trees and shrubbery. [1]

Fig. 8 - Shugakuin Imperial Villa Garden [22]

Fig. 9 - Shodenji, Kyoto. With Mt. Hiei in distance, captured by framed garden edge or 'shakkei' [23]

CORRECTIONAL ILLUSIONS

'The eye is satisfied only when the appearance is satisfactory'. [3] There have been instances through history where the fallacies of pure vision have been overcome by, in a sense, correctional design techniques. [7] Baltrusaitis, cited by Collins, discusses Vitruvius on the subject : [7, 13]

Since what is true appears false and things seem different from what they are, in representing them we must add or subtract. In the case of an architectural facade, this involves replacing straight lines by curves, thickening, raising, and inclining certain parts. Columns swell in the middle, their bases bulge, corner columns swell (by a fiftieth part of their diameter), architraves lean forward (by a twelfth part of their height). [7, 13]

A well known case is the construction of the Parthenon *(Fig. 10)* on the Acropolis in Athens (Greece). There are subtle details which separate it from any other temple of its time.

Fig. 10 - The Parthenon, Acropolis [25]

'Absolute straight lines' do not exist on the building, the peristylian columns 'taper on a slight arc as they reach the top of the building [...] (about 7cm) [...] to such a degree that they would meet at an altitude of one mile above the ground', which compensates for the impression that they lean outwardly at the capital. The columns also swell towards the middle, counteracting the effect of shrunken appearance, thus appearing straight, creating the illusion 'that they are swollen from entasis (tension) – as if they were burdened by the weight of the roof'. The stylobate, or podium, on which they stand 'bows on a gentle arc which brings the corners about 12 cm closer to the ground that the middle.', and the 'long lines of the architrave – the beam which surmounts the columns or extends from column to column – would appear to sag if it were actually straight'. [3, 24] *(Fig. 11)*

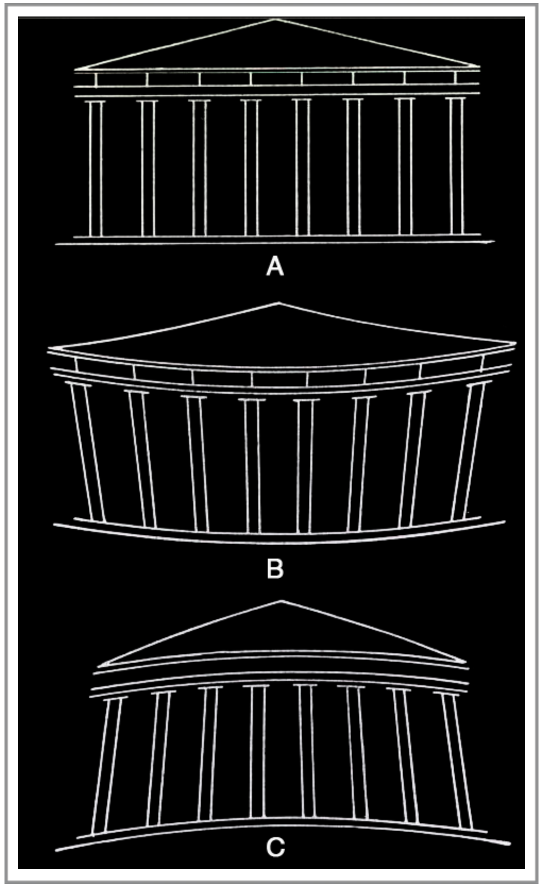


Fig. 11 - Parthenon elevational distortion representation [3]

(A) : As it should appear
(B) : Appearance (exaggerated) if it were built like (A)
(C) : As built, showing the physical corrections (exaggerated), so as to appear to the eye as (A)

The corner columns are made 'to be 1/40th (about 6cm) larger in diameter than all the other columns', and 'the space around them smaller than the rest […] by about 25cm.' This corrects the illusion created by the bright background of the sky, that they seem thinner and further apart than the other columns which stand in front of the darker building wall. [24] *(Fig. 12)*

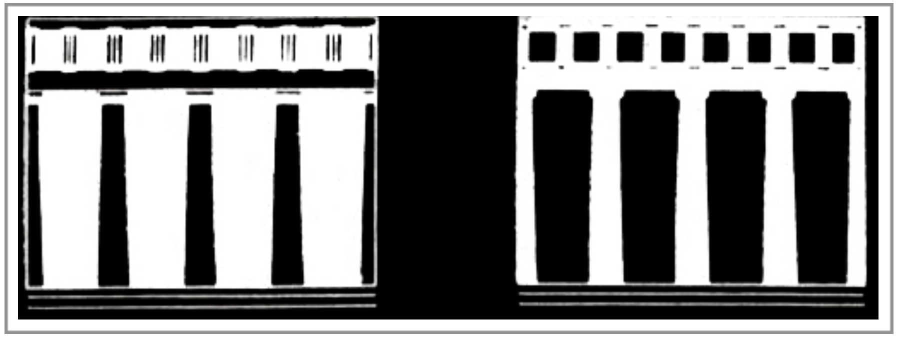


Fig. 12 - 'Irradiation in architecture'
'Columns viewed against a background of white sky appear of smaller diameter than when they are viewed against a dark background.' [3]

Based on a number of Ancient Greek studies, investigations were carried out by Rudolf, Galgemayr, Schwenter, and Werner into the difficult task of 'proportioning same-sized lettering on tall columns and walls'. [14] It is believed that letters of inscriptions set vertically on

ancient temples would appear to have equal size, from a certain viewpoint, by gradually increasing the size of the letters. [3] *(Fig. 13,14)*

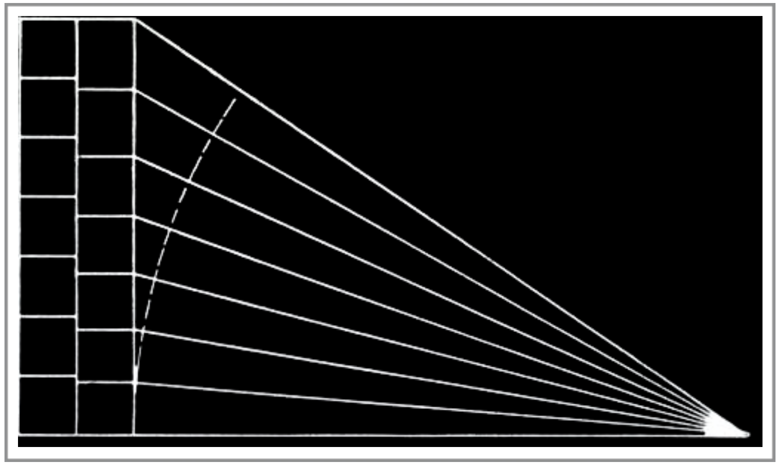


Fig. 13 - On the left are a series of equally sized squares in a vertical row. If these represent stories of a building or a tower, the individual sizes would present an apparent vertically progressive decrease. To counteract this visual effect, the squares must gradually increase in size [3]

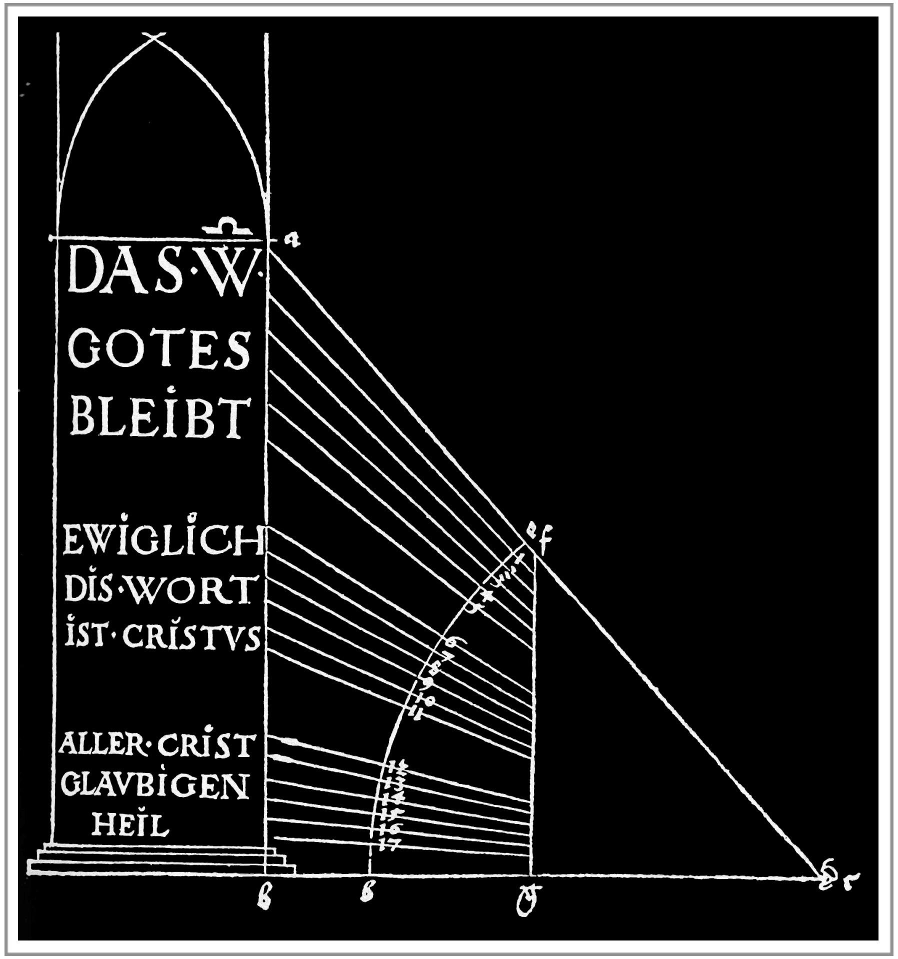


Fig. 14 - Diagram indicating the relative size of letters on a monument, to appear equal in size for an observer [10]

ILLUSION OF ‘DIMINISHING COURSE’

Using the same principal, inversely, an illusion of increasing size can be employed to a building or even a roof *(Fig. 15)* ‘by decreasing the size of its successive portions more rapidly than demanded by perspective alone.’ [3]

Fig. 15 - The roof appears to be much larger than in reality as the length of the slates become gradually smaller towards the gable [3]

No other illusionary technique is as well known as one artists and architects have been using for over 500 years as doctrine, known as perspective.

PERSPECTIVE - COMMON ILLUSION

An image created with linear perspective is 'an instantaneous section of the straight lines that join a point in space' along with the prominent characteristics of the objects in the scene. [26] It is a method used to represent 'a three-dimensional scene' which 'is inferred from a two-dimensional image'. This is an illusion that persuades the viewer that a three dimensional scene is before them. [12]

Vitruvius mentions Agatharcus of Samos, in Ancient Greece, to be the first to realise that parallel lines converge to a single 'vanishing point'. In 458 BC, he created 'perspectives' which were apparently painted upon a flat plane for the stage scenery for Aeschylus's, and in all probability Sophocles's, tragedies. [26-28]

The early history of perspective begins 'after the end of the Greco-Roman' period. For a long time the technique was forgotten, only to gradually resurface through artists. [7,13] It was developed during the Italian Renaissance, a time of 'rebirth' and explosion of artistic growth and discovery, when artists and architects explored, adapted, and mastered the technique for their creations.

The 'sciences of Antiquity' are believed to have been handed over from Islam through the Middle Ages, and even Euclid's work was translated, in the 12th century, from Arabic to Latin, instead from the original Greek. 'By a curious contradiction, it was the culture most hostile to vision in depth and in relief in painting and decoration that taught its principles.' Art and Science joined forces in Italy in the early 15th century, when artists such as Ghiberti, Alberti, Piero della Francesca, Leonardo da Vinci, Jean Pelerin (Viator), Durer, Vignola, Serlio, Barbaro, and Cousin 'applied mathematical theories methodically and elaborated procedures for dealing with all possible forms'. [7] 'Perspective was "the product of two disciplines - the study of optics and practical experimentation by painters."' [10]

An attempt to practice perspective on a large scale occured in Venice before man flew in balloons, when they could only imagine the earth from above. A well known 'birds-eye' map of Venice *(Fig. 16)* is described by Schulz, where Jacopo de Barbari illustrates a view of the city as a 'unified built environment'. The map was produced from observations at ground level, which were subsequently linked using calculations of the heights of the towers and the distance between them. There is a slight scale disproportion between the horizontal and

vertical axes, along with changes in angle between the individual map pieces, demonstrating the immense challenge of this task. [29, 30]

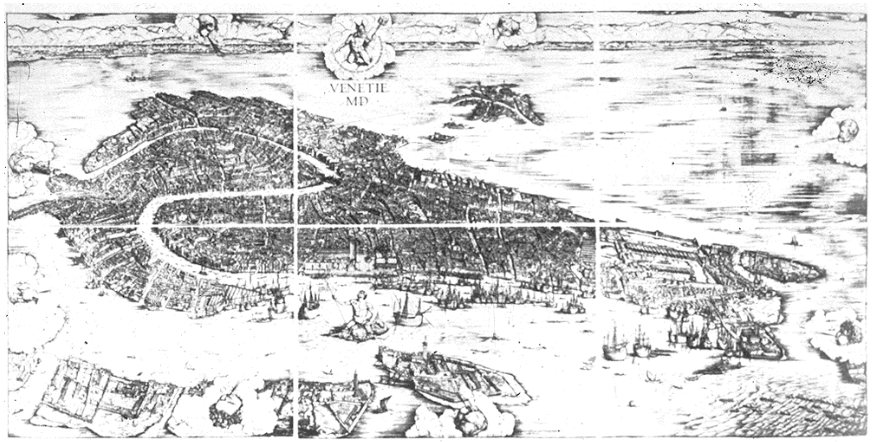


Fig. 16 - 'Bird's eye' representational map of Venice (1500) [29, 30]

TROMPE L'OEIL – ILLUSIONISM

Illusionism is defined as the application of 'pictorial techniques' in order to mislead perception into believing that painted scenes or images are reality. [31] Trompe l'oeil, which is French for 'trick of the eye', and occasionally referred to as illusionism, is a prime example of illusionary art where the observer is lead to view an image of a false illustration and perceive it as reality, if only instantaneously. 'The art originated from ancient Greece and was used widely by the Romans, only to become a lost art during the Dark Ages.' [12, 32]

The earliest record of illusionism was in ancient Greece, during the 5th to 4th centuries BC, when two opposing painters of high distinction, Zeuxis and Parrhasius, entered a contest. They were each challenged to produce a painting of an illusion that would greatly imitate reality. It is said that Zeuxis painted an impression of grapes, which seemed so genuine that 'birds flew down to peck at them'. Parrhasius presented a painting covered in a piece of cloth, which Zeuxis attempted to lift, but to his astonishment he realised he had lost the contest. It became apparent that the cloth was actually part of his opponent's painting. [32, 33]

Trompe L'oeil was reintroduced during the Renaissance, becoming the principal method of 'realistic visual representation', and continued gaining popularity later in the Baroque era, until the invention of photography. [1, 12, 32]

George Washington, the first president of the U.S.A, is suggested to have been deceived by an exceptionally realistic image of a man seemingly descending a stair. After entering the room he supposedly 'bowed to the figure' before realising the image was a painting. [1]

Villa Barbaro, circa 1559, designed by the Roman architect Palladio, consists of a plethora of trompe l'oeil paintings, by Paolo Veronese, of statues, spaces, landscapes, and even life-size figures of people peeking through doorways. [34] *(Fig. 17,18)*

Fig. 17 - Trompe L'oeil paintings of statues and life-size people, Villa Barbaro [34]

Fig. 18 - Trompe L'oeil paintings of statues and scenery, Villa Barbaro [35]

Peruzzi completed the Villa Farnesina, circa 1515, with a trompe l'oeil fresco, 'Salla delle Prospettive' *(Fig. 19)*, with precisely calculated perspective of a hall of columns and a landscape of Rome behind them. [36]

Fig. 19 - 'Sala delle Prospettive', Villa Farnesina [37]

As artists grew to master perspective, they developed the 'techniques of stretching and distorting images in various ways', which would seem clear through only one specific point in space. [12] Evolving from these geometrical representational studies, a new genre of illusions emerged. Though many applied linear perspective to their work, only few became proficient in as Niceron called it, 'inverse perspective', or Anamorphosis as it is known today. [4]

ANAMORPHOSIS

The art of Anamorphosis, which is 'closely related to trompe l'oeil [...] involves the process of greatly distorting an image, only to have it revealed either from a single vantage point of from its reflection in a mirrored surface'. [12]

Baltrusaitis refers to Plato and his work 'The Sophist' on this subject: "Works which, considered from a favourable viewing-point, resemble the beautiful but which, properly examined, no longer offer the resemblance they promised, are phantoms." Plato may have been referring to certain illusions, based on anamorphosis. [7, 13]

Quite often one finds the implementation of anamorphic practice 'from portraits to murals and scenography, to architecture itself.' Although this is contradictory to the 'praxis of anamorphic perspective', as it seems to be 'reserved to its creators alone', linear perspective was extensively practised. [14] Anamorphosis, as Collins suggests, is not merely a technique to view artwork from different viewpoints, but 'a metaphor for accepting information from unfamiliar places and unexpected sources'. [7]

It gained popularity through the 16th to 19th centuries, being 'used traditionally to depict aesthetic subjects one was reluctant to represent directly [...] the erotic, the scatological, the occult, the religious, and the philosophically abstruse' [7, 10, 12]

The 'Golden Age of Anamorphosis' occured during the 16th to 18th centuries when many artists excelled in experimenting with many types of anamorphosis, as it 'evolved both theoretically and practically'. The techniques became more accurate as the geometrical rules were better understood. The developed skills inevitably travelled to central and northern Europe. [10, 15]

A pupil of German artist Albrecht Durer, Erhard Schon's famous "Vexierbild" (Puzzle Picture) marvelled the minds of his time. [38] He examined the technique of anamorphosis by hiding a portrait amidst landscape scenes in his "Three Kings and a Pope" *(Fig. 20)*. Subsequently he followed the same approach to discreet drawings of explicit nature. [14]

Fig. 20 - “‘Vexierbild” (1535) - Erhard Schon
When these confusing forms combined with fragments of landscape (*left*) are viewed at an oblique angle, four portraits emerge from the chaos. Emperor Charles V, Ferdinand I of Austria (his brother), Pope Paul III and King Francis I (*right*)] [10, 38]

During the same period, Hans Holbein created the painting of ‘The Abassadors’, *(Fig. 21)* ‘a portrait of the two French ambassadors Jean de Dintevill and George de Selve’ , which elevated anamorphosis to its peak of popularity. Along with very realistic representation of objects (trompe l’oeil) in the scene, his misshapen figure at the bottom of the painting could only be deciphered by viewing it from an extremely oblique angle (anamorphosis), revealing a human skull. [12] *(Fig. 22)*

Fig. 21 - ‘The Ambassadors’ - Hans Holbein [39]

Fig. 22 - ‘The human skull can only be viewed correctly from an oblique vantage point [39]

Under the influence of Holbein's painting, William Scrots painted the anamorphic 'Portrait of Edward VI' *(Fig. 23)*. The correct angle of the image can be viewed from a small hole in the frame. [10]

Though many more experimented with these perplexing techniques, it is of great interest how the technique of anamorphosis evolved, beginning from the invention of its precursor during the Italian Renaissance.

Fig. 23 - 'Anamorphic portrait of Portrait of Edward VI - William Scrots [40]

THE RENAISSANCE

What separates the Renaissance from other periods in European history is the sudden cultural and intellectual growth, regarded to be triggered from stages established towards the end of the Middle Ages. [41] Beginning in Florence, the movement spread to other surrounding countries. [15,42] French for 'rebirth', it was a time when a fascination with the Classical eras of Ancient Greece and Rome were regained, as they were considered a 'golden age of wisdom and art'. [43] This was a period of glorification of humanity: 'Man is the measure of all things'. [15]

The uncertain economic and political state of the 14th - 16th century cities, along with a constant turbulent atmosphere over 'the historical situation' gradually led to a new era of 'intellectual, cultural, and social experiments' which resulted in the creation of 'a new European monocultural identity, one focused on humanistic studies, science, and the arts'. [41]

The term Renaissance was first used by Giorgio Vasari, an Italian artist and critic, in his book 'The Lives of the Artists' (1550), in order to define his perception of a new era, one which separated itself from the 'barbarities of gothic art'. [42, 44] The architects of the period, 'believing that their buildings had to belong to a higher order', explored the Ancient Greek system of proportions. This was used in music as well as design, as music was considered 'to be geometry translated into sound', thus 'architecture was mathematics translated into spatial units'. These proportions are encountered on dimensions of rooms and facades, as well as entire floor-plans. [45]

DISCOVERY OF PERSPECTIVE

Euclid wrote about the eye and how objects are perceived, in his work, 'Optics'. Its modern equivalent term is 'psychological optics'. [46] In the late 13th century, Witelo produced a collection of studies on '*perspectiva*', which was the Latin term for optics, in which he focused on the eye along with 'instruments "for the certification of sight", such as quadrants and astrolabes'. This consequently matured to a direct connection of instruments with optics, surveying and astronomy, while attempting to establish practical representation. [46]

Perspective, the representation of the world of three dimensions onto a surface of two dimensions, had been studied vaguely by ancient civilisations, though it seems to have been abandoned for over a millennia. Byzantine art dominated the Christian artistic world for over a thousand years. Representations of objects and figures resembled 'flat abstract symbols set on flat neutral surfaces'. Man was not to be portrayed as having a 'physical body', but merely a 'human spirit, having no volume, depth or position in space.'; Thus the third dimension and subsequently illusionism came to a standstill. [15, 47]

During the period most prominent architects, being educated as painters, explored the use of perspective, occasionally to its extreme limits. [26]

MASTERS OF PERSPECTIVE

Albrecht Durer illustrated the concept of perspective in his 'An artist drawing a nude' *(Fig. 24)*. Here, the artist adjusts his position at a certain point in space from which he views the subject through a 'window', a wooden frame enclosing an 'evenly-spaced grid of black strings'. The artist copies exactly what he sees onto the grid in front of him, thus accurately depicting the nude woman. *(Fig. 25)* 'Fundamental to perspective' are the concepts of the window and the certain point of view, so in order to accurately associate the image before us with the artist's, our view must coincide with his. [15]

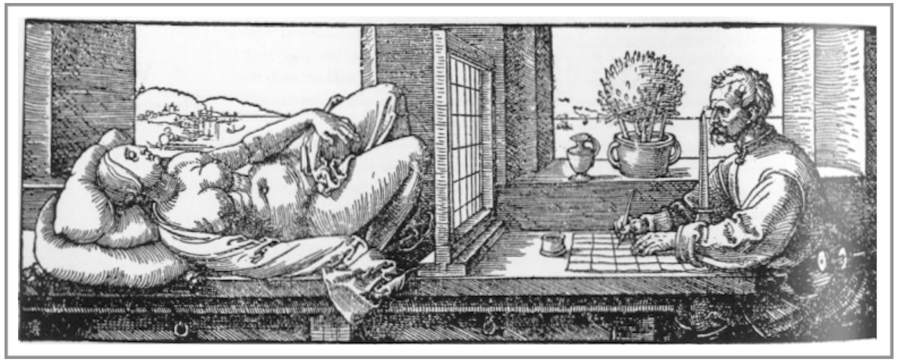


Fig. 24 - The artist views his subject through the grid 'window' and copies exactly what he sees onto the grid in front of him [48]

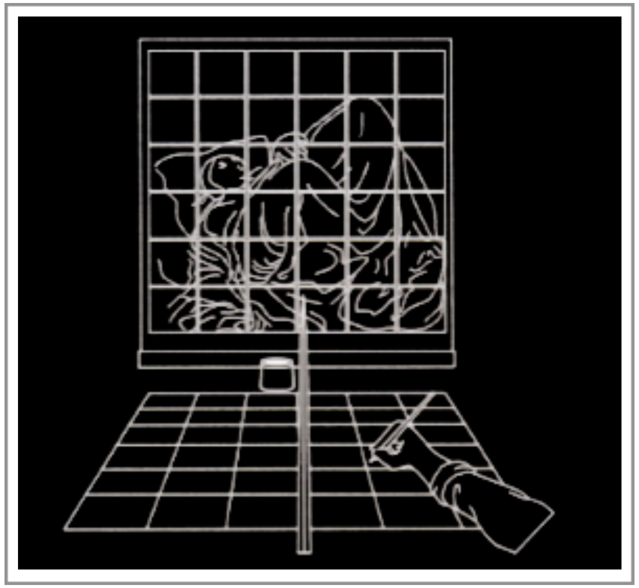


Fig. 25 - The artist's view through the grid 'window' [2]

Filippo Brunelleschi, one of the foremost architects of the Italian Renaissance, developed in the 15th century a theory of practical, or 'linear', perspective based on Euclidean studies of optics. [46] Leon Battista Alberti, a Florentine artist, mathematician, and architect, had great influence on the evolution of the Renaissance art. He was the first to formally describe the 'central perspective system' Brunelleschi had begun to formulate. [10]

Piero della Francesca was an Italian artist who expressed fascination with mathematics and perspective. He described in detail how 'ground plans must be altered in perspective construction', a technique which allowed the integration of buildings, of which the exact dimensions were known, into images, in addition to drawing fictitious views of buildings composed into cityscapes. [10] His 'Flagellation of the Christ' *(Fig. 26)* is an exemplary instance of meticulous perspective painting of the Renaissance. [46]

Fig. 26 - 'Flagellation of the Christ' – Piero della Francesca [49]

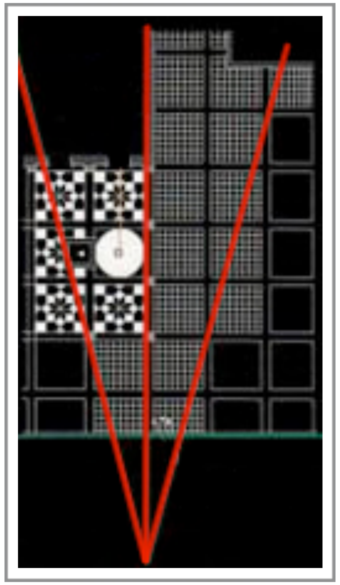
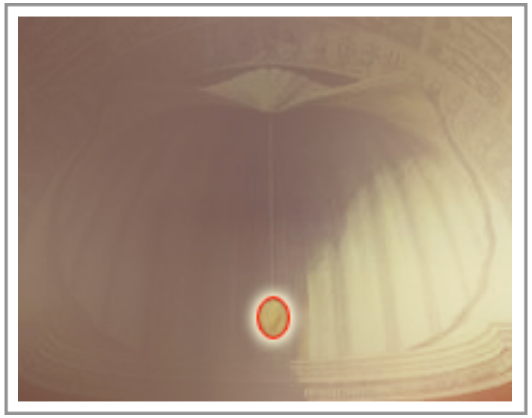


Fig. 27 - Analysis of the architecture in the 'Flagellation of the Christ'. Francesca's perspective is so accurate that the space can be calculated to high precision (Image adapted from [50]*)*

In addition, he was likely to have been the first to explore the impression of a sphere in perspective in detail in his 'De Prospetiva Pingendi' for his painting 'Virgin with Child, Saints, and Angles' *(Fig. 29)*. A spectator may be attracted to an ovoid body hanging from the end

of an ornate shell above the vaulted niche *(Fig. 28)*. A perfect sphere would be expected to be have been more appropriate for the symmetrical theme of the scene, but when viewing the same object near the central axis of the painting, the shape is perceived as a perfect sphere. It is perhaps the first illustration of 'anamorphic projection' being superimposed on 'linear projection'. [14]



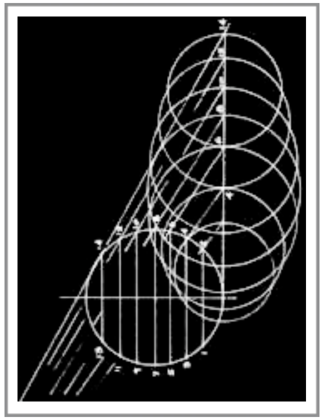


Fig. 28 - 'Highlighted detail of apparent ovaloid hanging form [51]
The hanging shape is perceived as a perfect sphere from a different viewing angle than the painting [14]

Fig. 29 - 'Virgin with Child, Saints, and Angels' - Piero della Francesca [51]

Many other artists and architects, such as Bramante, Borromini, Bernini, Palladio, Pozzo, and Michelangelo investigated what the mystery of perspective could offer them, but Leonardo da Vinci brought the technique to a new level.

Leonardo's interests ranged from painting, sculpture, architecture, and engineering to mathematics, biology, and geology. [52] He made the distinction between natural and artificial perspective, the former being based on the optics of Euclid, where 'we seek to discover rules that reflect our own observation', and the latter being used in art with Alberti's technique; as an observer's angle of vision minimises, the space between him and an object maximises, thus the space between Alberti's artificial perspective lines, which run parallel to the two-dimensional plane, minimises. In fact, the opposite occurs; as the size of objects on a painting seems to decrease, as the observer's angle of vision decreases, the painter attempts to portray that the space actually increases. [10]

He explains that natural perspective, the visual plane on which artificial perspective is represented, is flat and based on the observer's point of view, this plane's extreme portions seem to minimise to a greater extent than the ones near the viewer. He continues with an example of artificial perspective *(Fig. 30)*, where three equal circles are positioned beyond a vertical plane, and a spectator sees the them as sections, the middle one appearing smaller than the others. [10]

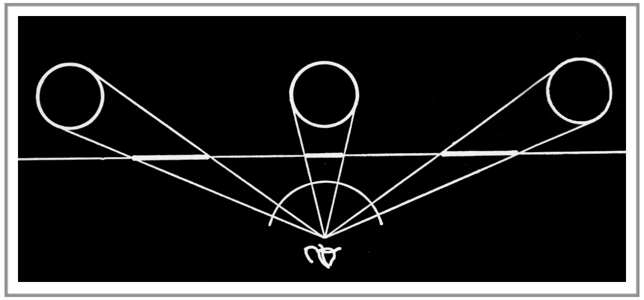


Fig. 30 - In his sketch, Leonardo attempts to show that objects that are further than the spectator's point of view seem larger than those closer. (Adapted from [10])

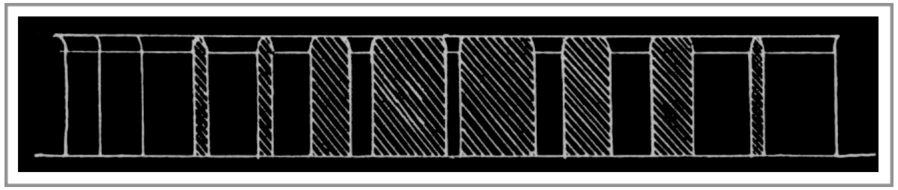


Fig. 31 - Exaggerated representational view of columns, following da Vinci's example [53]

In this example, only a single spectator would be able to correctly see the image from the determined point in space, while any other spectators would be confused by a disordered image. As a result, he demonstrated the contrasting nature of artificial and natural perspective. For 'normal' paintings, meaning ones created merely with artificial perspective, he recommended 'a distance between image and eye at least three times as great as the height of the image', creating a generally satisfactory view for spectators not situated at the prime viewpoint. [10]

Da Vinci proposed the possibility of combining 'naturalis' with 'artificiulis', 'natural and artificial perspective in one picture', resulting in '*prospettiva composta*', a composite perspective. He produced a further example, *(Fig. 32)* starting with a foreshortened square (a, b, c, d) viewed from an established viewpoint, and a distorted tetragon form (e, f, g, h) behind the former which would appear to coincide with it, thus merging the two perspectives. [4, 10]

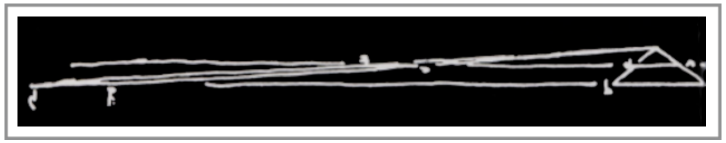


Fig. 32 - Leonardo's sketch of foreshortened square and distorted tetrahedron example [10]

Da Vinci goes on to describe a possible method for creating a 'composite':

If you want to represent a figure on a wall, the wall being foreshortened, while the figure is to appear in its proper form, and as standing free from the wall, you must proceed thus: Have a thin plate of iron and make a small hole in the centre; this hole must be round. Set a light close to it in such a position that it shines through the central hole, then place any object or figure you please so close to the wall that it touches it and draw the outline of the shadow on the wall; then fill in the shadow and add the lights; place the person who is to see it so that he looks through the same hole where at first the light was; and you will never be able to persuade yourself that the image is not detached from the wall. [10]

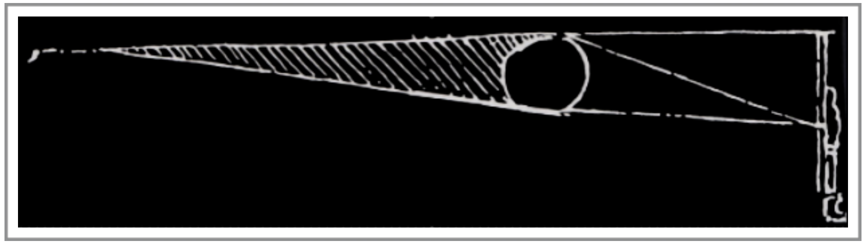


Fig. 33 - Leonardo's sketch of his proposed experiment of tracing the projected shadow of an object on a wall [10]

He consequently 'cleared the path' for further studies on anamorphosis, which essential evolved naturally as a 'peripheral manifestation of artificial perspective'. [10]

EVOLUTION OF ANAMORPHOSIS

An anamorphosis is 'a distorted or monstrous projection or representation of an image on a plane or curved surface, which, when viewed from a certain point, or as reflected from a curved mirror or through a polyhedron, appears regular and in proportion'. [54]

The etymological origin of the word, from the Greek *ana* (again), and *morphe* (shape), which mean to 're-form' or 'transform', implying that the observer must play a part in the process and assume an 'uncomfortable' position to bring sense and harmony to the image. [10] 'The spectator makes the picture'. The observer must actively participate in the process, while being on the same level as the object, thus 'the identity of the viewing subject is reinforced and reaffirmed. [7] One must thus become a part of the art.

Anamorphoses are highly subjective and more rigorous forms of geometric perspective, where the viewer is presented with an image which is barely identifiable and then is forced to seek the viewing angle which satisfies the formal construction of the image. [10] They are derived from 'precise mathematical and physical rules', ones which govern two-dimensional representations of the three-dimensional environment. However, they are intentionally created in unorthodox ways to bend or even break common perceptions. [15]

The term 'anamorphosis' was invented by the Jesuit Gaspar Schott (1657), around 150 years after the first appearance of the technique. Prior to him it was known by several names, such as '*prospettiva inversa*' by Giovanni Paolo Lomazzo, who in his 1584 treatise on painting first illustrated an elaborate approach for creating anamorphic drawings by projecting an image through a grid system, while looking through a peephole, [4, 55] and '*perspective curieuse*' by Jean-Francois Niceron, a mathematician who published a treatise on optics and artificial perspective, in which he explored the 'geometric elaboration of anamorphosis'. [4, 11]

The term 'inverse' or 'reverse' perspective was not believed to be satisfactory, as the same title belonged to a 'Medieval practice of "splaying" orthogonals instead of making them converge'. [4]

LINEAR / ANAMORPHIC PERSPECTIVE

We are accustomed to viewing images straight on, and even when we view them from an angle, we are compelled to adjust our position perpendicular to them. [10] However, anamorphosis urges us to consciously engage in the act of separating ourselves from the image and discern a 'virtual object that insists upon invading' our visual field, while in essence, as Collins suggests, we exchange our common binocular vision to 'a "cyclopean" view', as the effect is greater with only one eye open. [7]

When one's sight 'moves towards the edges of the perspective plane', a warping impression of the image is created. It is very similar to the same effect produced by transferring the image onto a subsequent surface. The distortion of the former, although occasionally misconstrued as anamorphic, is not precisely valid; 'the perspective elongation produced by increasing the angle of the visual field is in the same plane as the image', while an accurate anamorphic projection can only be produced by the latter method. [14]

Linear perspective presents a logical and practical connection with the viewer, while the effect of anamorphosis causes confusion and doubt before the viewer rationalises the vista. [7] Massey refers to Baltrusaitis, who discusses that as sight seems to be rationalised by perspective, anamorphosis perhaps reveals its own ability to de-rationalise itself. [4, 13] As well as being considered a technique based on 'classical methods of perspectival representation, it is also one that attempts to subvert it. Though Collins argues that it 'should be viewed less as an assault on the field of vision than as a supplement', and that in these 'wrinkles in the field' we may find those entities that 'literally and figuratively' have been left to the sidelines. [7]

THE FIRST ANAMORPHOSIS

Leonardo Da Vinci is most possibly the first to explore the technique of anamorphosis. In his Codex Atlanticus (1485), currently found in the Biblioteca Ambrosiana in Milan, are two extremely elongated sketches, one of an eye and the other of a child's head *(Fig. 34)*. When seen from the 'ideal' viewpoint, the dysmorphic figures seem to detach from the scene and 'float in space'. [10, 31] *(Fig. 35)*

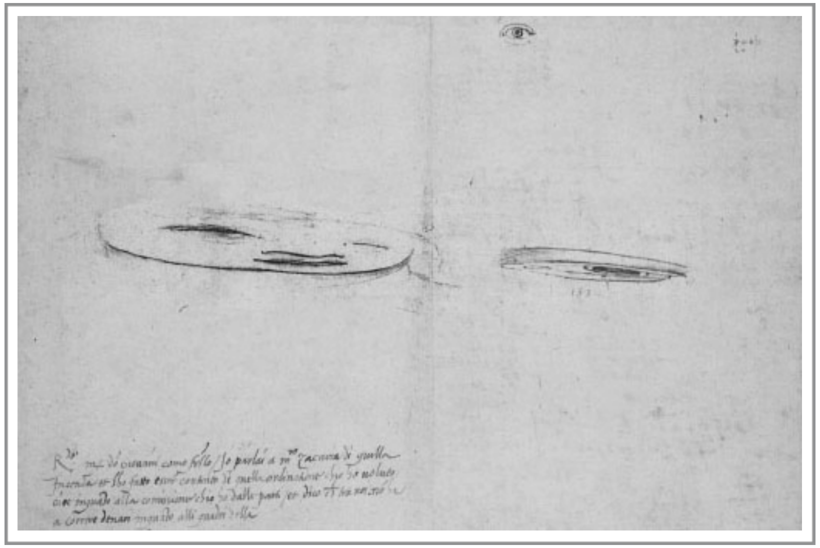


Fig. 34 - Anamorphosis of a child's face and an eye – Leonard da Vinci [56]

Fig. 35 - Distorted view of Fig. 34 from correct viewing angle (using Adobe® Photoshop®)

Da Vinci's anamorphic experiment was most possibly based upon Dürer's 'grid window', as the artists of the period began to realise that the window did not have to be orientated perpendicular to the artist's central axis, but could be skewed and tilted, *(Fig. 36)* thus creating a distorted and sometimes even unrecognisable image when viewed from the conventional position. [15]

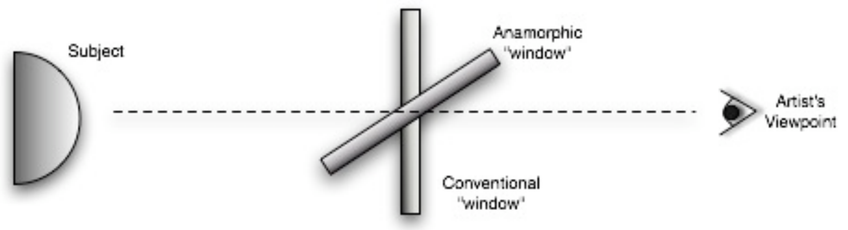


Fig. 36 - Tilting Durer's grid 'window'
(Adapted from [15] *)*

As well as being interested in lateral distortion on flat surfaces, he apparently found curved surfaces on walls, ceilings, and domes appealing, where the angle of vision is moderately skewed in relation to the painted surface. [4] *(Fig. 37)*

Fig. 37 - Projection of an image of a man on a wall and vaulted ceiling – Leonardo da Vinci [10]

A significant similarity between linear and anamorphic perspective is the control over the 'distance point'. Da Vinci very likely initially suggested that Alberti's method assumed the use of a hypothetical point in space in the horizon whose depth between it, the picture plane, and the viewer would be hypothetical as well. A second point would be positioned further than the image's boundaries, completing the impression of depth. Leonardo considered the method to be 'mathematically precise', as he supposedly was capable of calculating the distance an observer was recommended to be positioned from the image, as well as the distance between any identifiable point in the scene and the observer, by merely knowing the span of the base of the painting in 'braccia'. An artist thus possesses the advantage of manipulating these points, a fact that Leonardo was wary of, as excessive distortion could easily present itself. [4]

Niceron proposed that in 'common' perspective a hypothetical plane is placed between the observer and the illustrated object, however in an additional 'curious' perspective, he suggested that the object places itself between the observer and the plane. [4, 11]

In anamorphic perspective the distance point transforms into, 'at the limits of possibility, the actual viewpoint', seemingly producing a 'boomerang effect in which the image originates and ends at the same point. [...] The movement to "clarity" involves the collapse of distance between subject and object.' [4] *(Fig. 38)*

As the space between the distance point and the vanishing point decreases, the subject and the object merge into one existence, while the image suspends freely in space. Anamorphosis thus creates an individual point of view which relies on 'de-spatialised vision'. [4]

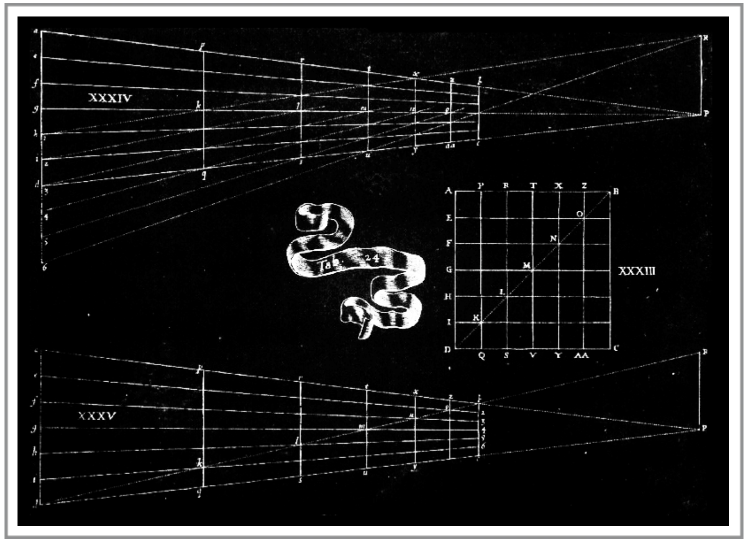


Fig. 38 - Anamorphic grid with distance point and principal point – Niceron [4]

STUDIES ON ILLUSIONISM

St. Ignatius Church, Rome - Andrea Pozzo

In the church of Sant'Ignazio one may view a striking scene while admiring the churches cupola. It is in fact a flat plane decorated with a trompe l'oeil painting. [14] *(Fig. 39)* The false vault was created not for a theatrical or decorative purpose, nor as an artistic experiment, but to solve a problem of constructing an actual dome. The church's perimeter walls were too high and would overshadow the dome, and if it were elevated, to compensate, it would seem disproportionate from the interior; thus a vault that would appear as a 'fortified tower' externally was proposed. A solution though could not be agreed upon. [14]

After several decades, it was decided not to build the vault at all, but to employ Andrea Pozzo to paint an illusory domed space, which would resemble the original, if it had been built. [14] A skillful Italian artist and architect, his mastery in perspective was celebrated. He gained much reputation by creating illusionary scenes and structures, including church cupolas, colonnades and buildings. [57]

He first calculated the precise perspective for the design of the vault on a 17m large canvas (*intelaiatura*), in order to project a hemicylindrical scene onto a flat surface. The space he was able to complete this was 'on the floor at the centre of the church's crossing. The method he used to produce the effect was described in his treatise 'Perspectiva, Pictorum et Architectorum' (1693). [14]

Fig. 39 - The painted dome, 17m in diameter, on the flat ceiling was painted as an allegory of the Apotheosis of S. Ignatius. The observer must stand on a brass disc set into the floor of the nave to view the illusion correctly [10, 58]

The illusion is very intense, it is nearly impossible to perceive it as actually a flat plane. The 'architecture' of the painting had been criticised by a number of architects, who indicated that as the columns supporting the dome rest on 'consoles', such a structure would not function in reality. Pozzo ironically responded that he would 'bear all damages and charges' if the supporting stones ever broke and the columns fell to the floor. [10]

Fig. 40 - Geometrical analysis of the false vault's geometry overlaid on Fig. 39 [14, 58]

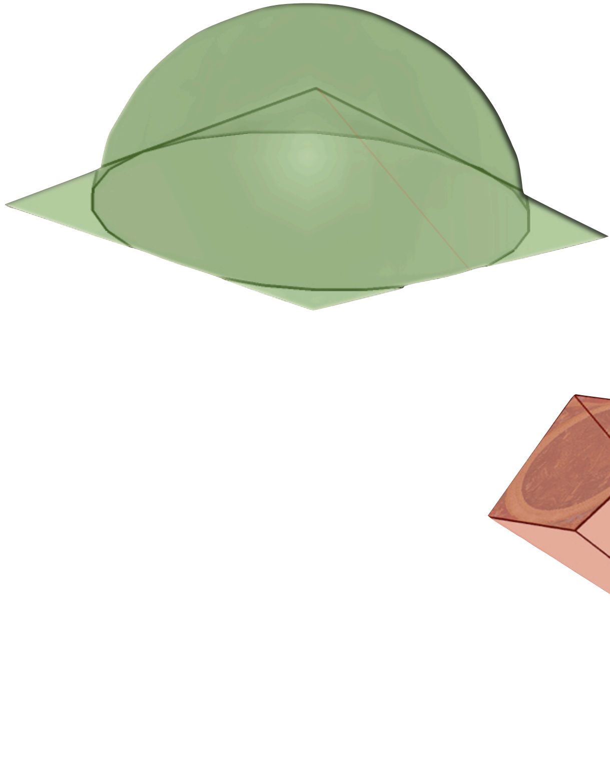


Fig. 41 - Three-dimensional representation of an observer's ideal viewpoint to perceive the illusion of the cupola. (Model created using Google™ Sketchup™, projecting image from Figure 39)

Salgado believes that the anamorphic effect is more powerful when the observer's view is inverted, seeing 'the painting upside down.' [14]

Fig. 42 - View of the false cupola from the other end, displaying the inverse illusion. (Distorted view of Fig. 39 using Adobe® Photoshop®)

In the same church, not far from the illusionary vault, he also created an immense trompe l'oeil fresco in the nave, the 'Entrance of Saint Igniatius into Paradise'. *(Fig. 43)*

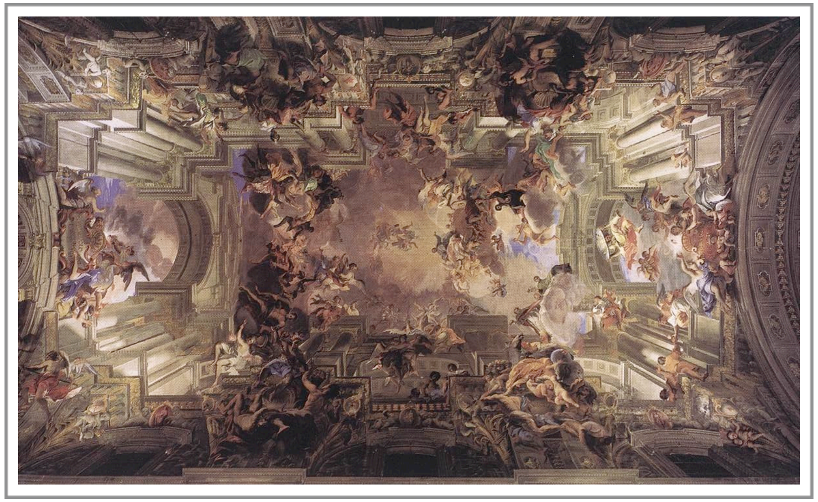


Fig. 43 - 'Entrance of Saint Ignatius into Paradise'
'In the centre, the saint is carried up to heaven, while the four continents, converted to the faith, attest from the earth to his glory' [10]

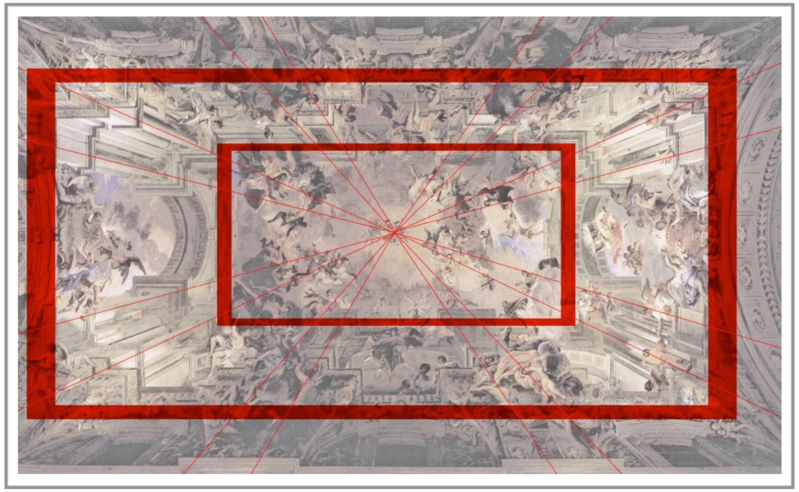


Fig. 44 - Analysis of the painting's geometry overlaid on Fig. 43

He was faced with the challenge of projecting the flat surface onto the curved vault of the church. At first he drew the architecture in the painting as if it were actually being built, subsequently projecting the entire drawing onto a horizontal plane, which was positioned where the vertical wall meets the vaulting ceiling. He divided his design into squares, creating a grid which would simplify the process. [10]
(Fig. 45,47)

Pozzo devised a plan of stretching an analogous grid of strings at the height of the hypothetical plane, while placing a light source at position 'O' (the observer's viewpoint) and tracing the projected shadows which would be cast on the vault. However, the shadows of the figures were too blurred to trace. He solved the problem by replacing beams of light with strings stretched from position 'O' to the ceiling, transferring the grid of the drawing successfully. *(Fig. 46)* The final illusion is so convincing, that from the distant position of the observer, the actual shape of the vaulted ceiling is nearly impossible to distinguish. [10]

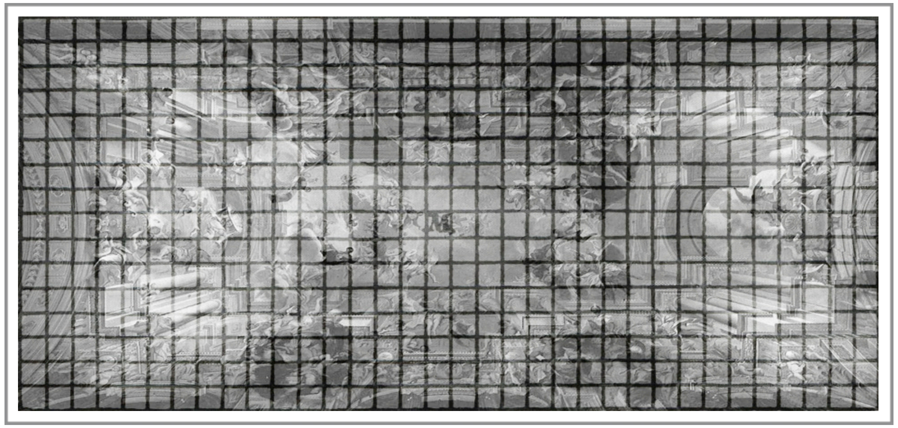


Fig. 45 - Representation of Pozzo's design divided into a grid to simplify the process. (Grid overlaid on Fig. 43)

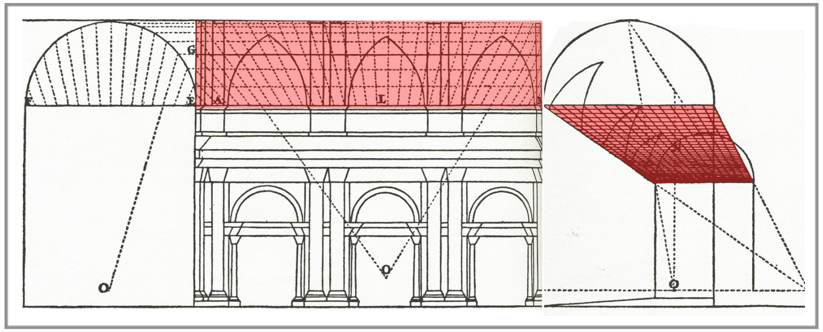


Fig. 46 - The nave of the church was filled with a grid of strings at the height of the hypothetical plane, and then stretched even more strings from the position 'O' to transfer his design to the vault. (image adapted from [10])

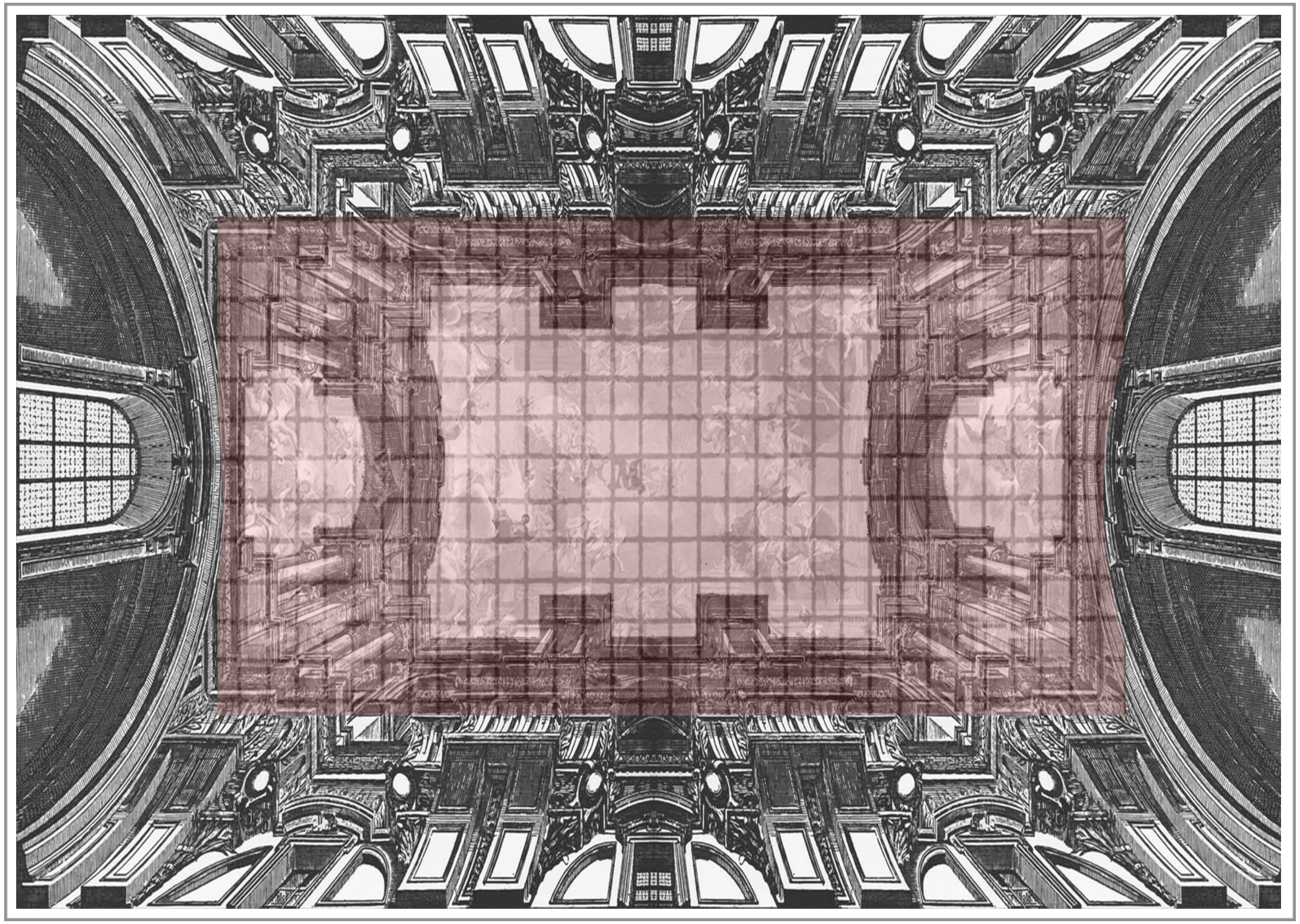


Fig. 47 - Representaion of the projected painting divided into a grid at the suitable height. (Fig. 45 overlaid on image from [10])

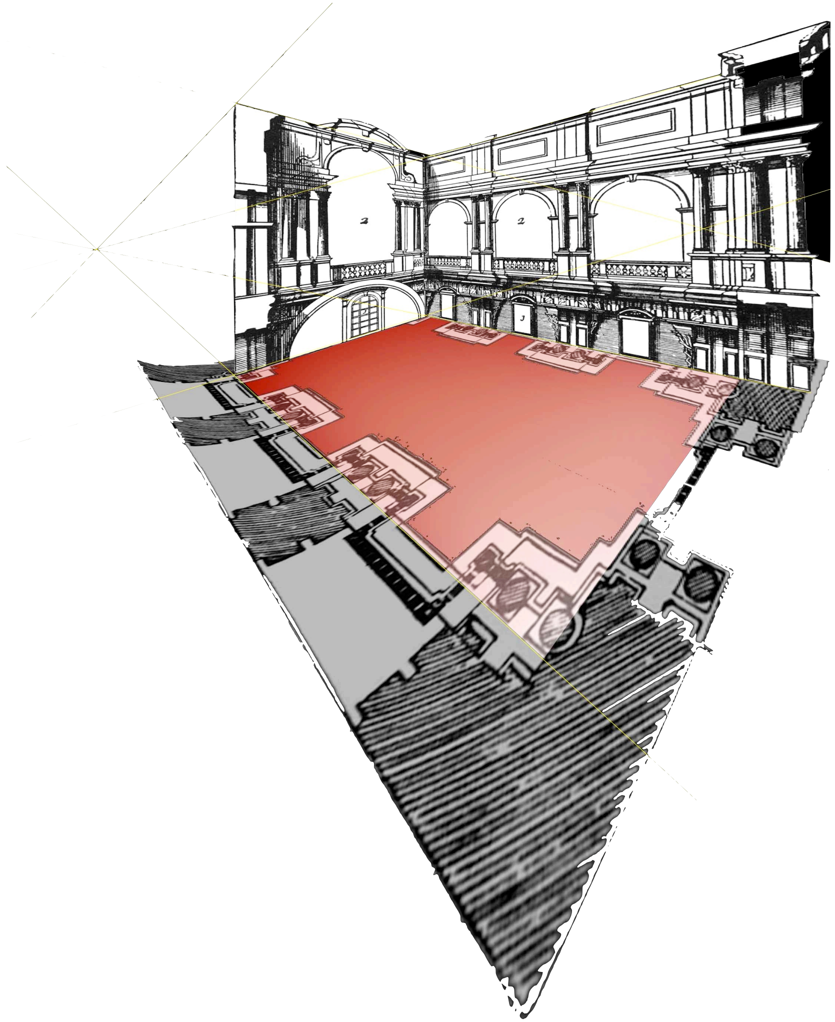


Fig. 48 - Distortion of the hypothetical elevations and floorplan of the painting, as if it were built.
The notional floorplan aided in the precision of the illusionary structure.
(Elevations and floorplan taken from [10] *and distorted using Adobe® Photoshop®)*

Fig. 49 - View of the vault from non-optimal vantage point [37]

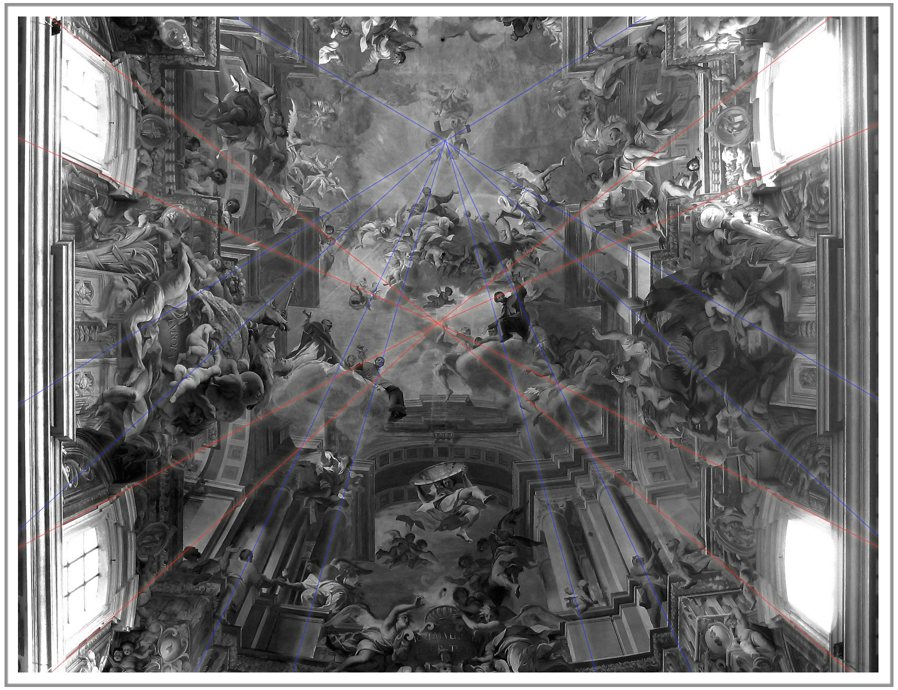


Fig. 50 - Analysis of hypothetical perspective lines overlaid on Fig. 49
The blue lines represent the intended perspective in the image, and the red ones the observer's current perspective. When the blue and red lines coincide in the centre of the room, the illusion appears flawless

Santa Maria Presso di San Satiro, Milan - Donato Bramante

Commonly known as 'San Satiro' the church of Santa Maria Presso di San Satiro *(Fig. 51)* features one of the first examples of anamorphosis in architecture. Donato Bramante (1444-1514), one of the most influential architects of the Renaissance, demonstrated his command of proportion, perspective and trompe l'oeil with the creation of a prime example of anamorphic relief.[10, 59]

Fig. 51 - Exterior façade of Santa Maria Presso di San Satiro (Photo taken by the author)

When entering the church, one sees a long nave and an almost equally long apse behind the altar. *(Fig. 52)* Though while approaching the altar, the first impression seems to fade and the truth is revealed. *(Fig. 53)* The entire choir, including the arcades and the vault, diminishes to a stucco relief of only a metre deep.[2,10]

Bramante was faced with a planning problem. The city street behind the church blocked the area where the apse had been planned to be constructed. The site did not permit a building deep enough to accommodate all the parishioners, so he 'escaped the limitations' of the volume by designing a 'false' apse.[2,10] What appears to be a 6m (or more) deep apse, behind the altar, is actually no more than 97cm. The illusion is realised by painting pillars of diminishing heights together with a vaulted ceiling, all of which converge towards a vanishing point at the height of the observer. [2]

'Through systematic deformation of familiar architectural details within a limited space, the impression is created that the wall is actively extended'.[10]

Fig. 52 - The false apse seems much deeper than in reality [59]

Fig. 53 - Oblique view of the false apse, displaying the distortion of the intended image [60]

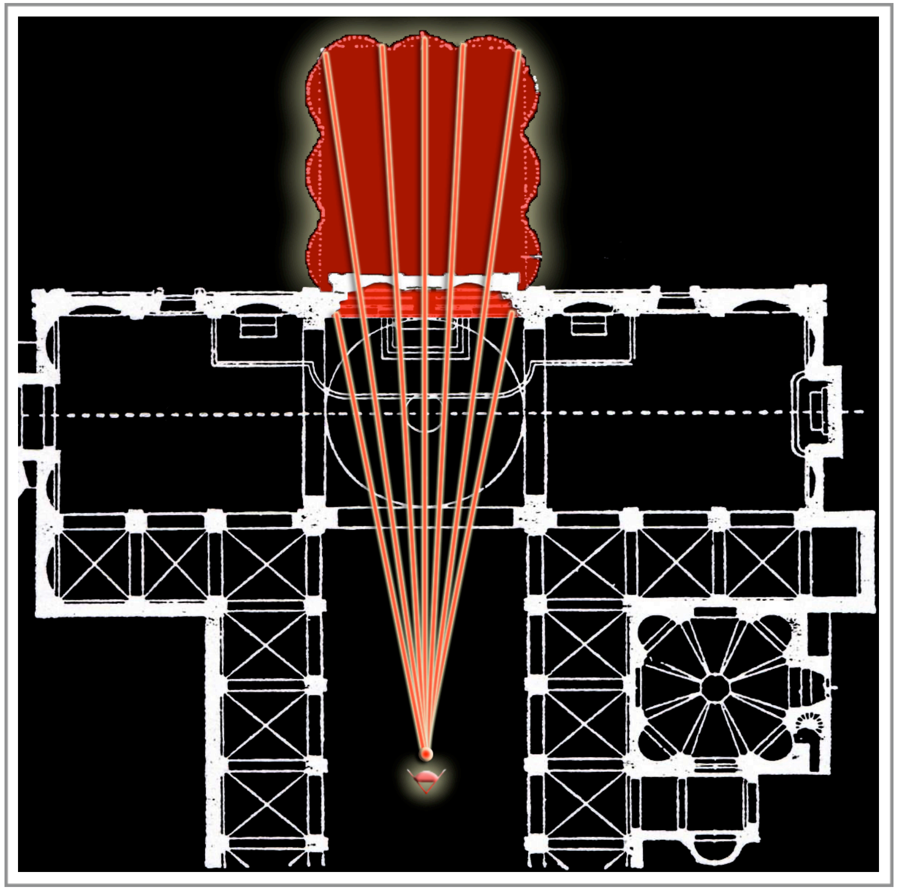


Fig. 54 - Representation of observer's position in the nave to view the illusion perfectly. The red lines represent the parts of the relief and their relative illusionary points. (Image adapted from [10, 61])

Fig. 55 - Front view of the false apse. The red lines represent the parts of the relief and their relative illusionary points. (Image adapted from [59,61])

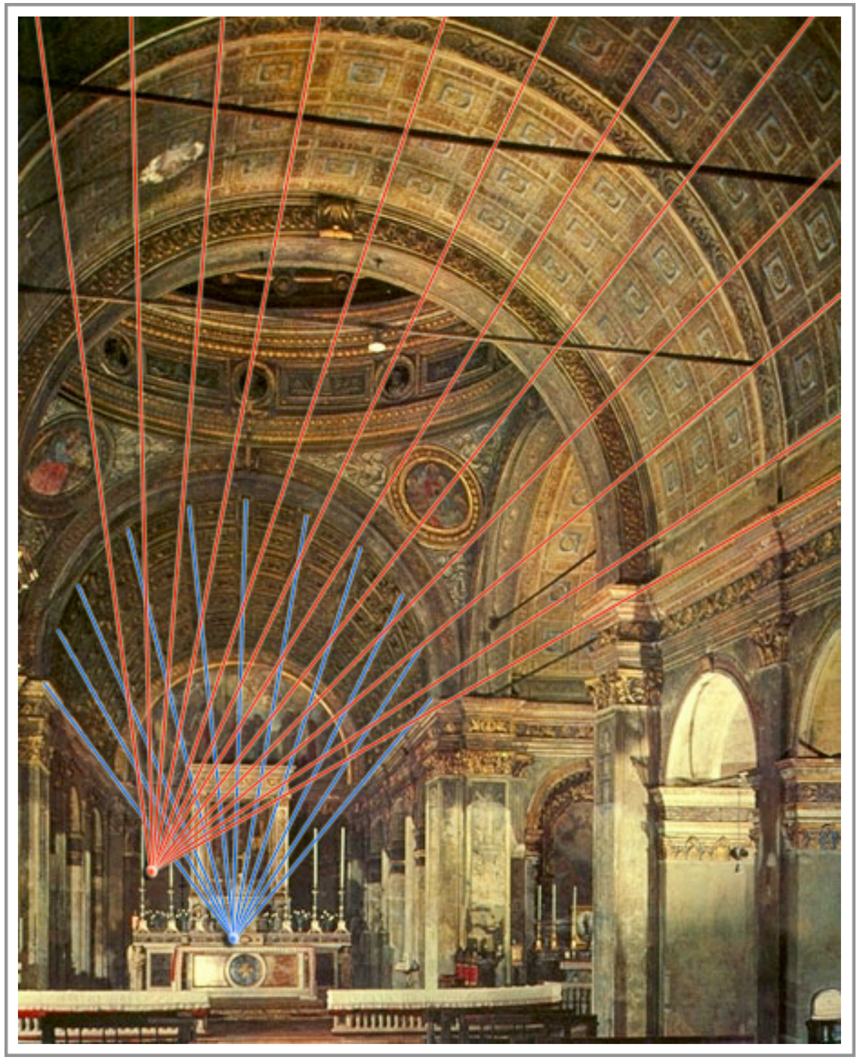


Fig. 56 - The blue lines represent the intended perspective in the image, and the red ones the observer's current perspective. When the centre of the blue and red lines coincide, the illusion seems to materialise. (Lines overlaid on image from [62])

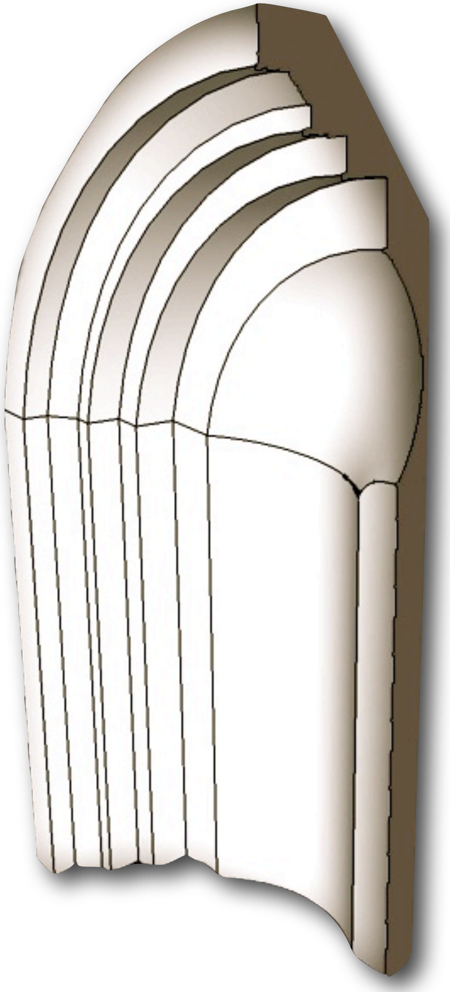


Fig. 57 - Sectional three-dimensional model of the false apse (Model created with Google™ Sketchup™)

Fig. 58 - Representation of an observer's position in the nave to view the illusion perfectly. The red lines represent the parts of the relief and their relative illusionary points. (Image adapted from [10, 61]*)*

Scuola di San Marco, Venice - Tullio Lombardo

While walking towards the Scuola di San Marco, an observer at a certain distance is confronted with the principal entrance which sits between two barrel-vaulted galleries, in which the lions of St. Mark stand guar. *(Fig. 59)* The illusion is produced by a series of anamorphic perspective reliefs, which were sculpted in 1490. The secondary entrance *(Fig. 61)* exhibits a similar illusionary view, in fact two scenes from the life of Saint Mark displayed under coffered ceilings; on the left 'The Healing of Anianus', and on the right 'The Baptism of Anianus'. [1 0]

Fig. 59 - Main Entrance of the Scuola di San Marco (Photo taken by the author)

Fig. 60 - Detail of façade, where a lion of St. Mark stands guard (Photo taken by the author)

Fig. 61 - Secondary entrance, displaying the illusionary coffered ceilings and the two scenes of the life of St. Mark (Photo taken by the author)

Fig. 62 - Detail of façade of secondary entrance, showing the 'Healing of Anianus' (Photo taken by the author)

Teatro Olimpico, Vicenza - Andrea Palladio

Since the end of the 16th century, stage scenery artists have achieved extreme foreshortening of forms and spaces, producing the illusion of cities with long streets, or even vast fields with distance mountains, in a very limited space behind the main stage. By the 17th century architects began to implement these techniques, giving birth to a period of 'world-as-theater', or 'illusionistic scenographic architecture'. A renowned case of the early period is Andrea Palladio's final piece of work, the 'Teatro Olimpico' in Vicenza. [10] *(Fig. 63)*

Fig. 63 - Interior view of the 'Teatro Olimpico' [63]

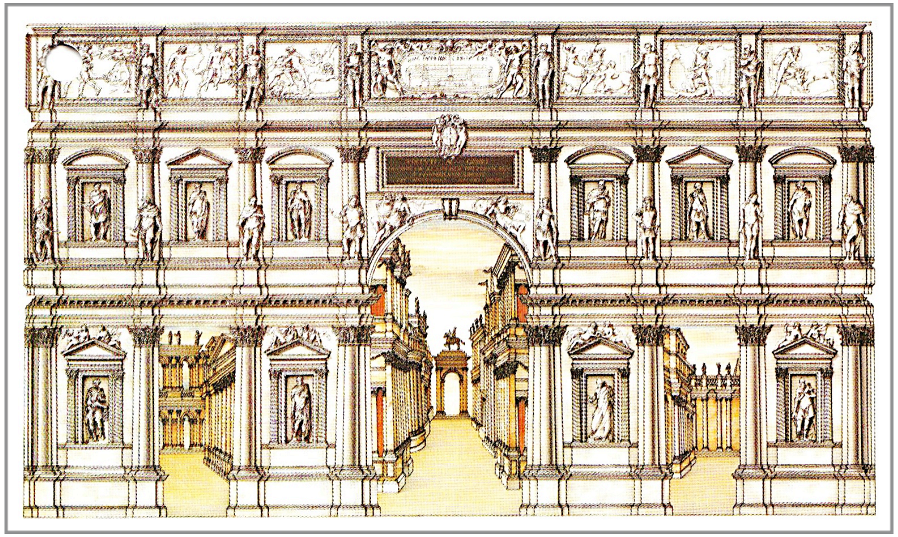


Fig. 64 - Representation of stage elevation showing the three main illusory 'streets' [64]

Based on Roman design, the amphitheatre's proscenium is adorned with ornate statues. *(Fig. 64)* The background of the stage is made up of five passageways, which lead through wooden streets to the 'distant view' (*prospettiva*). The streets appear much longer than they are in reality, as the floor gradually inclines upwards while the ceiling inversely does the same. The facades on both sides decrease in size as they seem to converge towards the back of the scene. [10]

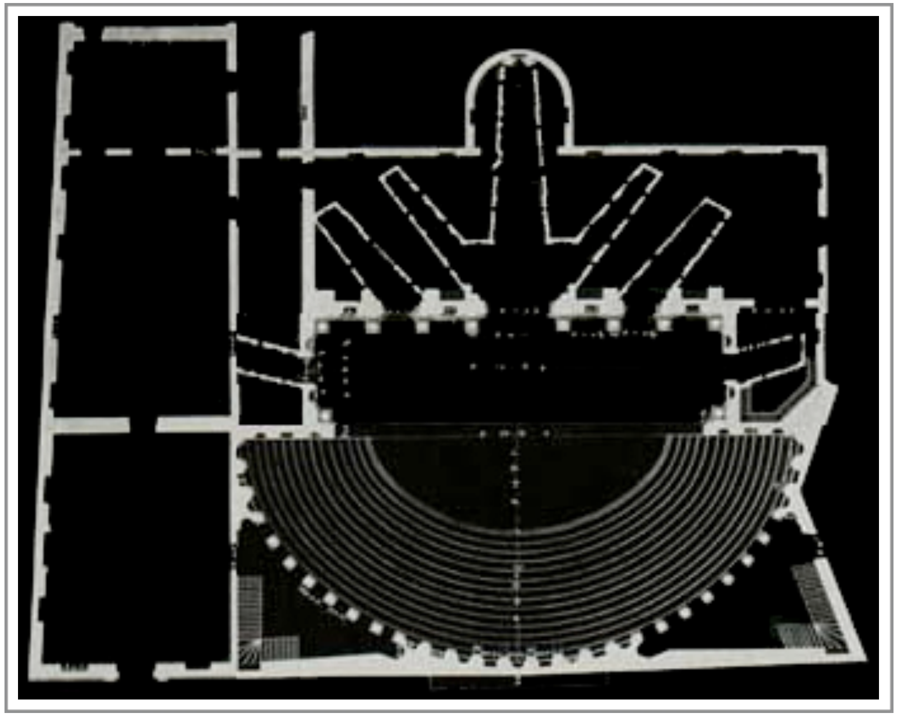


Fig. 65 - Plan view of the theatre.
The form of the five 'streets' are hidden behind the proscenium [65]

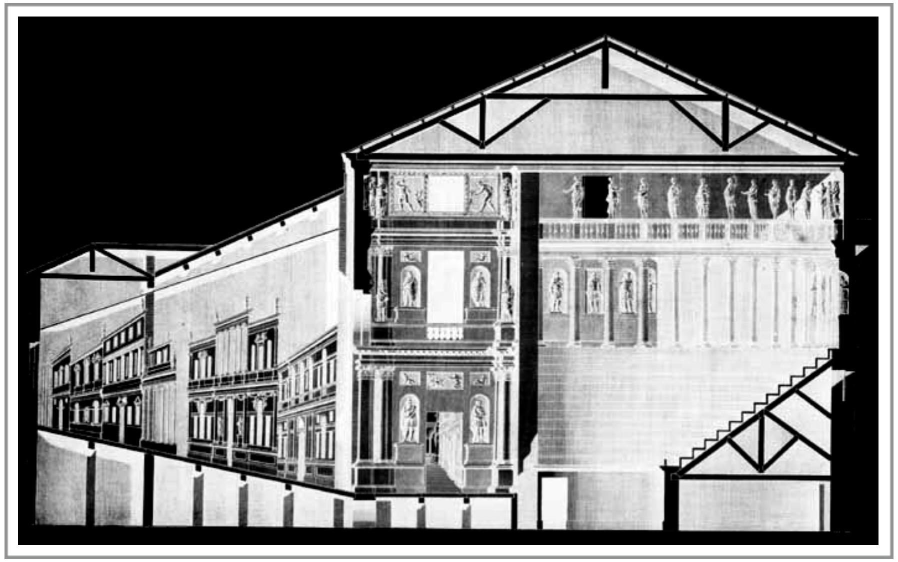


Fig. 66 - Sectional view of the theatre through the main 'street'. The floor, ceiling, and walls are inclined to produce elongated views. [66]

Palazzo Spada, Rome - Francesco Borromini

Similar to Palladio's technique used in the Teatro Olimpico, Borromini used structural elements at precise diminution to create a spatial illusion. At the end of Borromini's colonnaded corridor *(Fig. 67)* is an interior courtyard which seems to be more than 35m away from the entrance, though it is merely a depth illusion; the distance is in fact only 8.58m. [10] *(Fig. 68)*

Fig. 67 - View of corridor from entrance - Palazzo Spada [68]

Fig. 68 - The illusion of distance dematerialises, showing that the ceiling height differs greatly relative to the figures of similar height [69]

The floor, the ceiling, and the walls are inclined, producing a strong impression of depth, beginning from the 5.6 m high and 3.12 m wide entrance, to the 2.45 m high and 1 m wide opening on the courtyard side. [10] The sculpture in the courtyard is merely 60 cm high. [67] Despite the fact that the corridor is a real passageway, it leads into a 'blind court'. 'Reality thus becomes a theatre'. [10]

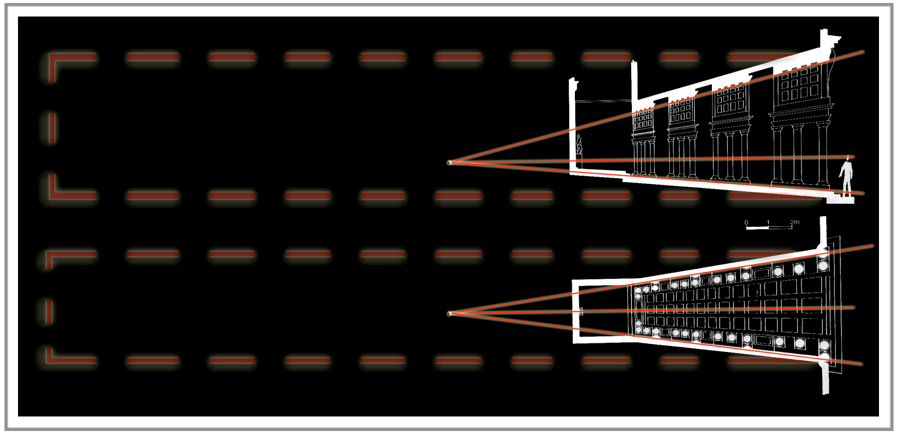


Fig. 69 - Sectional and plan view of the structure, showing the actual and perceived sizes. The ceiling, floor, and walls are inclined seeming to converge towards a single point in the distance. (Analysis of image from [67])

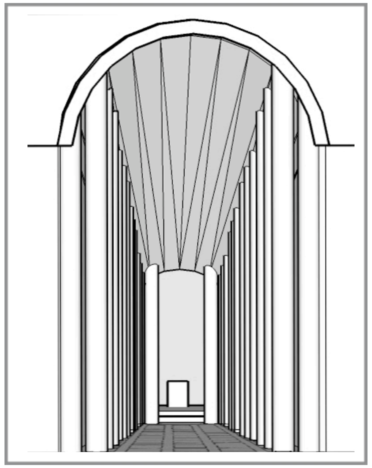


Fig. 70 - Elevational view from the entrance. The inclination of the floors and ceiling is clearly visible. (Model created with Google™ Sketchup™)

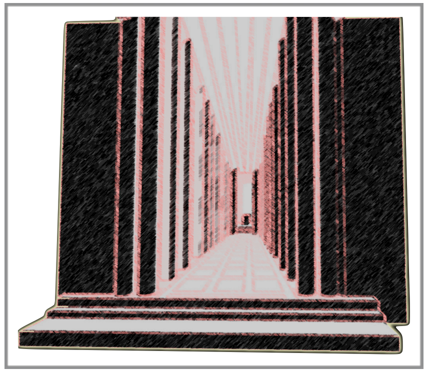


Fig. 70 - Three-dimensional representational view from the entrance. The perceived distance is stretched by the angles of the structure and the spacing of the columns. (Model created with Google™ Sketchup™)

CONTEMPORARY PRACTICE

During the early period of discovery of anamorphosis, artists occasionally explored it just as a counteraction against the 'conventual' linear perspective. Its emergence during the 20th century was 'driven by a search for new metaphors and methods of expression', partly aided by the discovery of new technologies, which expanded its functionality and understanding. Anamorphosis has had great impact on a number of disciplines directly associated with the science of optics, such as ophthalmology, photography, astronomy, and film-making. [7] Architecture currently presents some substantial examples:

Ames Room – Adelbert Ames Jr

The 'Ames room' presents a combination of anamorphic and accelerated perspective. It at first appears to be typical room with a checkered floor, *(Fig. 71)* though it is composed of an inclined floor and walls of trapezoidal form, where figures of similar size seem to differ greatly as they move between corners of the room. [14,70] *(Fig. 72,73)* The complete illusion can be viewed through a peephole in one of the orthogonal walls. The observer's perception seems to be satisfied with the apparent geometry in the room, as the corners of the room seem equidistant from the peephole. It was named after Adelbert Ames Jr., an American painter and psychologist, who created the first one in 1946, though H.L.F. von Helmoltz, a German physicist, mathematician, and physiologist, formulated the concept in the 19th century [71,72]

Fig. 71 - The subject appears to be double in size at the other corner of the room (Analysis overlaid on image from [73])

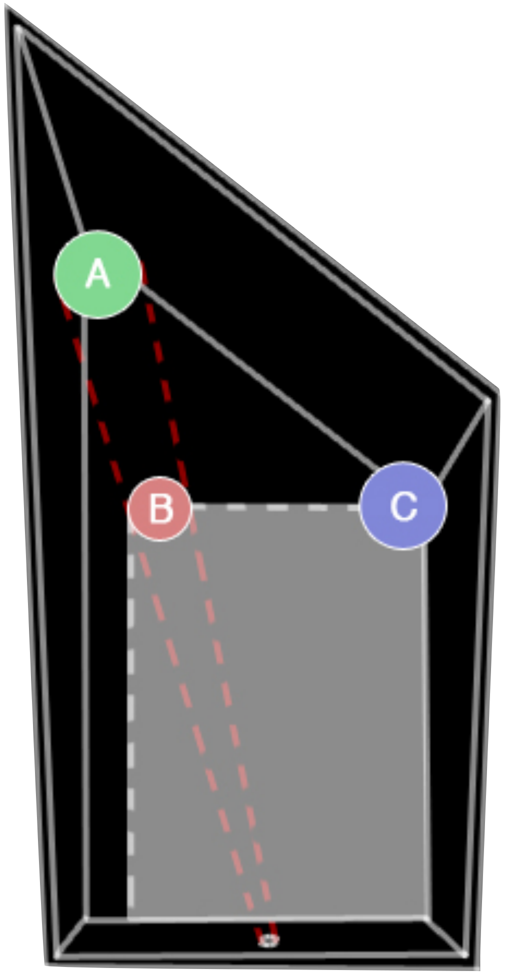


Fig. 72 - Plan view of the Ames room, depicting the perceived rectilinear shape of the room, the apparent position of the subject (B), actual position (A), and the equally sized individual at the opposite corner (C) (Image adapted from [74] *)*

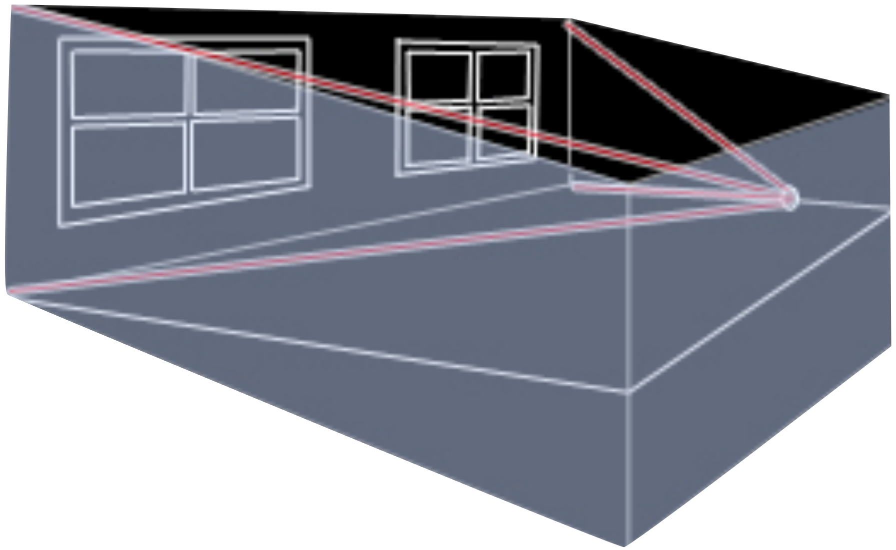


Fig. 73 - Three-dimensional representation of the Ames room (Image adapted from [75] *)*

Chapel of Notre Dame du Haut, France - Le Corbusier

'One of the icons of 20th century European architecture', this expressionist modernist chapel created in 1955 gives the impression that it was 'designed from the inside out'. Following traditional European precedents, a nave divides the volume, while side chapels 'puncture the massive main roof' permitting controlled light to illuminate them individually. [76]

Fig. 74 - Chapel of Notre Dame du Haut [77]

On the south wall of the church, pyramidal shaped windows puncture the dense structure *(Fig. 75,76)*, creating an 'array of anamorphic perspective boxes, collapsing and stretching the perception of relative size'. [26]

Fig. 75 - View of the south wall. The anamorphic pyramidal-shaped windows puncture the dense structure [77]

Fig. 76 - Interior view of the chapel's south wall. Beams of light flow through the windows projecting their shape into the nave. [78]

Architectural murals - Richard Haas

Richard Haas, a modern trompe l'oeil artist and AIA gold medal winner, is believed to one of the most significant architectural muralists. Using the urban environment as his canvas, his illusory images deceive, entertain, and enhance observers' experiences. The murals are accurately viewed within a certain angle. One of his first projects, 'Prince St.', stunned viewers in 1975 . [1] *(Fig. 77,78)*

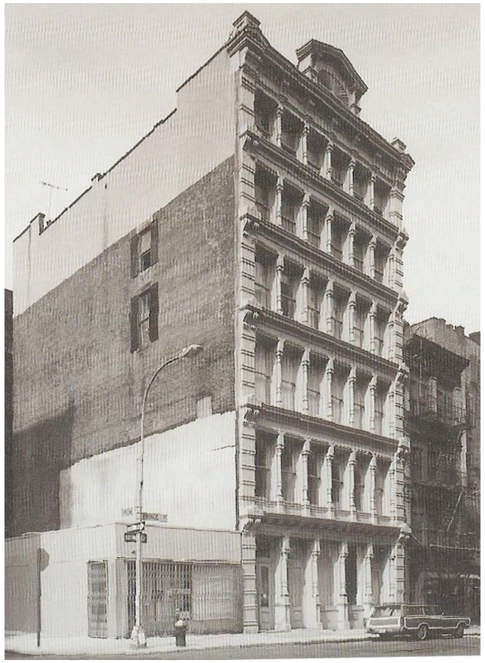


Fig. 77 - Prince St. project -1975 (before) [79]

Fig. 78 - Prince St. project -1975 (after) [79]

Architectural murals - John Pugh

A master of architectural illusionism, Pugh integrates his paintings into the architecture to an extremely realistic level. 'The viewer is perplexed as to where reality begins'. [80]

Academe Taylor Hall - Chico (California)

His first major commission, Taylor Hall *(Fig. 79)* brought him international recognition, as his 'illusion of hyper-realism' appealed to a great number of spectators. He used the Doric column, an easily identifiable symbol, to represent the 'concept of the Greek Academe as the basis of the educational systems in Western culture. [80]

Fig. 79 - Main view of Taylor Hall showing the trompe l'oeil painting [80]

Fig. 80 - Detail of the illusionary painting of Doric columns [80]

Fig. 81 - Detail of the 'broken' wall [80]

Art Imitating Life Imitating Art Imitating Life – San Jose (California)

At 'Café Tromp L'oeil', or currently 'Café Espresso', *(Fig. 82)* the illusionary mural integrates 'pre-existing surrounding material' to virtually extend the cafe. The painting seems to 'erase the transitional line between reality and illusion', by including realistically painted elements, such as chairs, tables, floor materials, types of wood, and plants, to be 'consistent with the real interior environment of the café. [80]

Fig. 82 - Art Imitating Life Imitating Art Imitating Life [80]

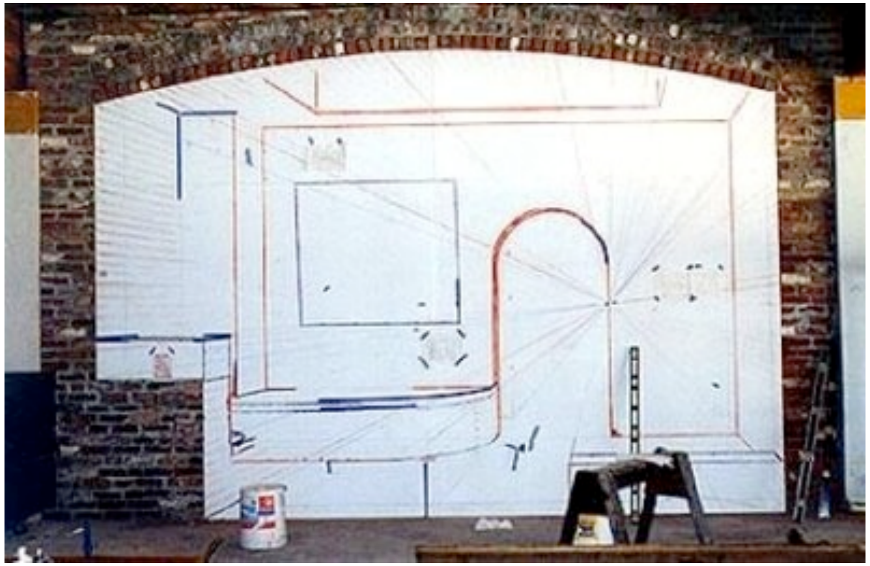


Fig. 83 - At the early phase in the painting, real bricks were placed around the outline on the café wall as a prop [80]

Apparently the illusion was so successful, that a complaint was issued to the manager of the café, as a male customer had unsuccessfully tried to introduce himself to the woman sitting at the table and had 'received the "silent treatment"', completely oblivious to the fact she was part of a painting. [80]

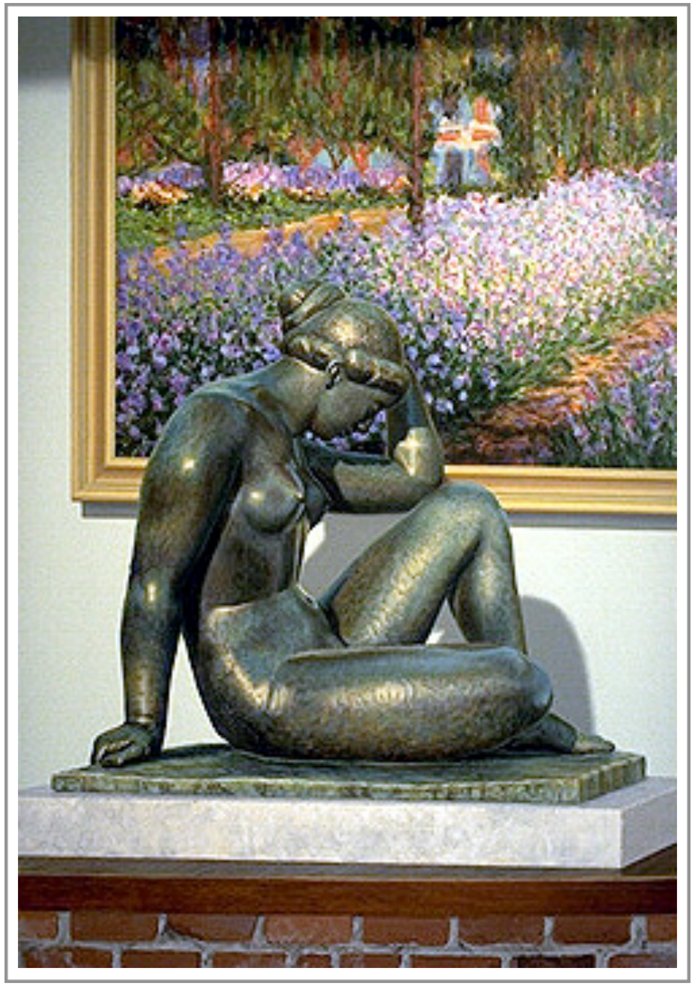


Fig. 84 - Detail of the illusionary statue [80]

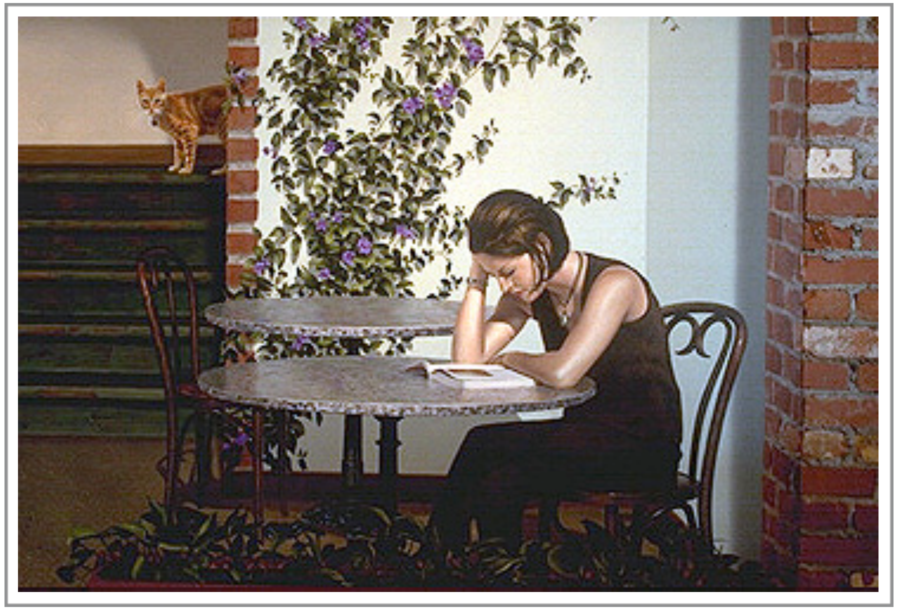


Fig. 85 - Detail of the illusionary woman [80]

SkyCeiling™ - Sky Factory™

Illusionary art is not only used for decorative or entertainment, or deception purposes, they also serve a more practical use of aiding the healing process. An increasing phenomenon in healthcare facilities is the use of illusory scenes of nature. Patients' recovery times seem to reduce, along with the need for pain medication, which subsequently minimises the patients' and the hospital's costs. [1]

Recently opened, Sentara Williamsburg Hospital is a 139-bed facility designed as a replacement affiliate of the National Planetree Alliance. It follows the Planetree Model's guidelines to provide 'a comfortable and warm environment' with solitary as well as social activities, and is clearly designed to provide a great amount of light, fresh air, acoustical control, as well as views to the gardens. Illusions have a significant place in the 'healing design' of the building, particularly illusions of nature. In the MRI (Magnetic Resonance Imaging) scan rooms *(Fig. 86)* and the pre-/post-operative recovery rooms *(Fig. 87)* are ceilings with illusory skies, which mainly promote relaxation. An alternative to typical ceiling tiles is the use of SkyCeiling™, which in essence are high definition images of the sky. [1]

Fig. 86 - SkyCeiling™ installed over an MRI scanner [81]

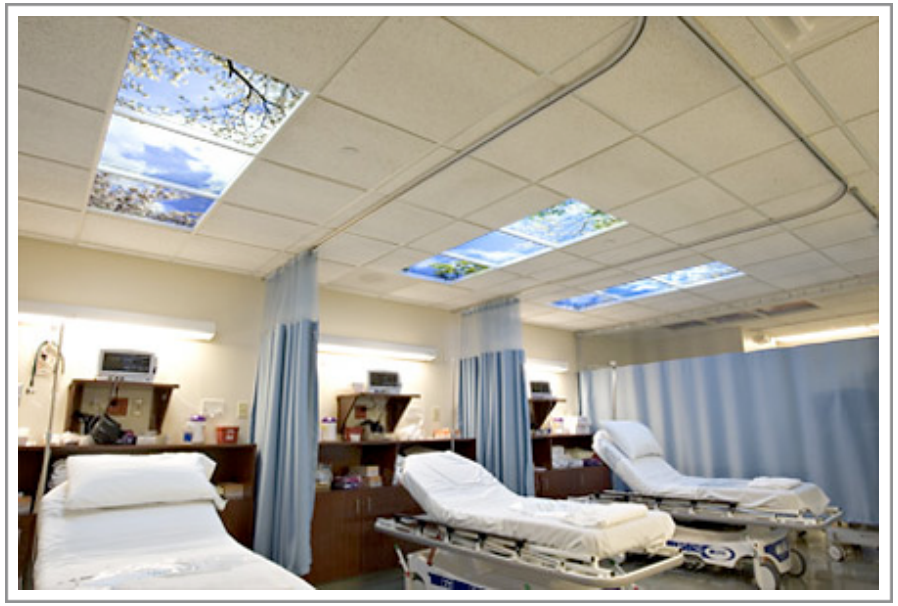


Fig. 87 - SkyCeiling™ ceiling tiles over the patients' beds in the recovery room. They help them relax, making them 'experience less pain and recover faster' [I]

As the sky is generally viewed not only directly, but also through our peripheral vision, sky ceilings are advantageous to staff and visitors as well. A vast blue sky is used in the illusion, because it is a universal connection to nature, one that instantly reduces stress levels and helps to relax as it activates psycho-physiological responses, while providing 'a sense of space, freedom, comfort and well-being'. Precise simulation of natural representation is necessary to produce the psycho-physiological effects related to authentic natural experiences; consequently the benefit of the image on the patient depends directly on the accuracy the illusion. True perspective is an important element, as with the sky, when one observes a cloudy sky, the underside of the clouds can be seen directly above, though progressively to the horizon the sides are visible as well. Similarly without clouds, the hues and values of luminosity and colour seem to differ. [I]

The SkyCeiling™ is photographed so as to reproduce this 'curvature' of view. 'One end of the sky ceiling is above the observer's head and the other is above their feet.' An experiment was performed to test the reactions of the patients, depending on their viewpoints; it was found that if the zenith of the image is placed above the observer's head, and the end of sky is above their feet and approximately fifty-two degrees from the beginning, *(Fig. 88)* then it would mimic, to a high degree, the situation if there were actually a same size aperture and a real sky above. Though if the sky ceiling were to be inverted, with the zenith above the observer's feet, then the view would appear abnormal. [I] *(Fig. 89.90)*

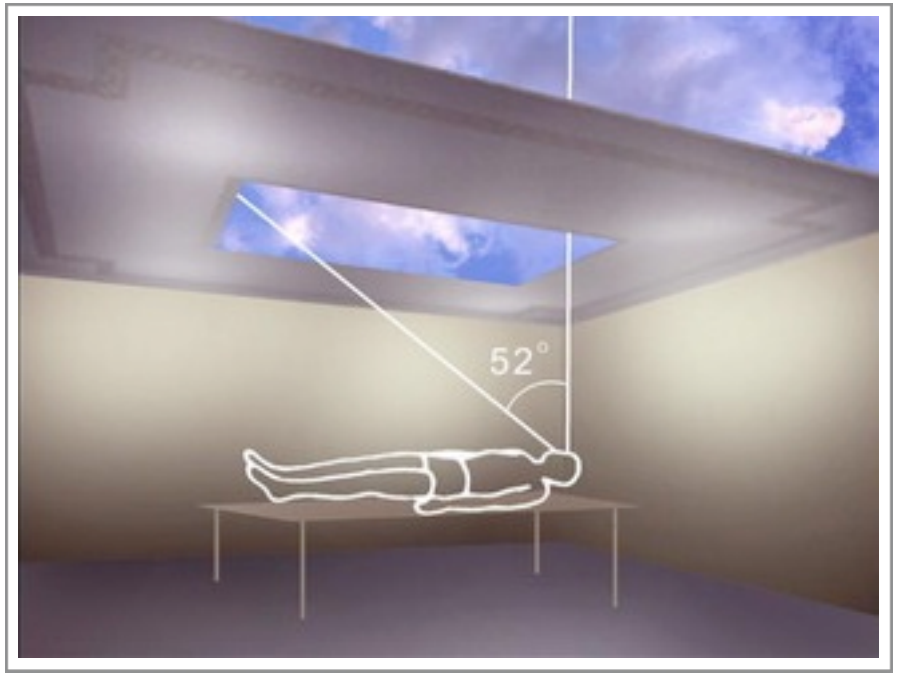


Fig. 88 - Representation of the correct viewing position (the image's zenith above the observer's head), and angle (around 52^0) towards the horizon. [82]

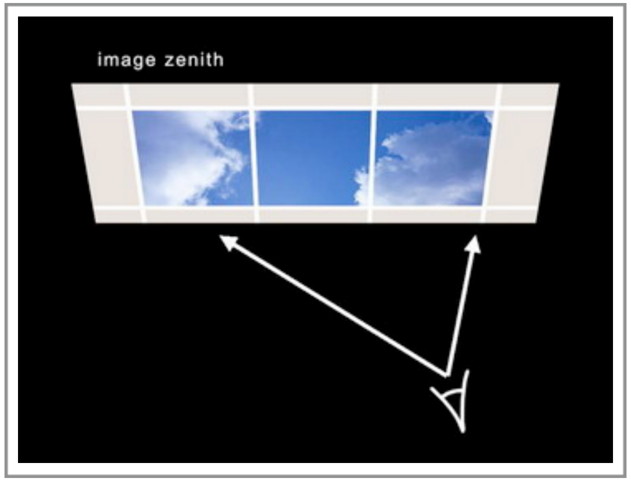


Fig. 89 - Representation of the correct viewing direction of the ceiling (zenith at patient's feet) [82]

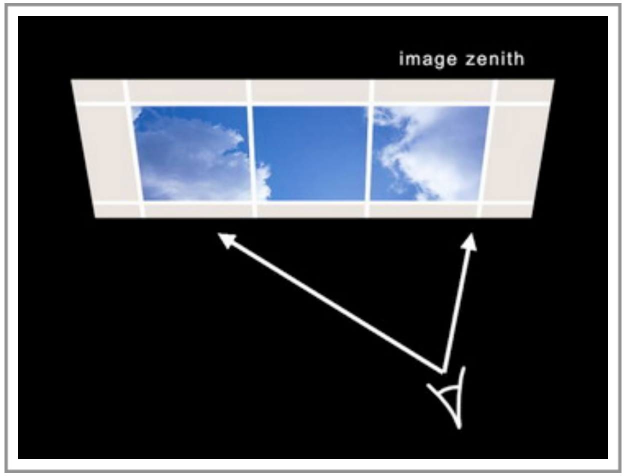


Fig. 90 - Representation of the incorrect viewing direction of the ceiling (zenith at patient's head) [82]

CONCLUSION

Illusionary techniques utilised to control the proportions and appearance of characteristics of buildings have been practiced throughout history to deceive spectators' perception of spaces and structures. In my dissertation I have attempted to show how the techniques of perspective, anamorphosis, and trompe l'oeil evolved to be employed in architecture to virtually expand or simulate spaces. To do this I have presented examples from early and cotemporary developers and masters of the practices, as well as analysed a number of them in two- and three-dimensional detail to understand the methods they used to manipulate the perceptions of observers.

Anamorphosis has been demonstrated to be a progression of linear perspective, as well as a negation to its common practice. It has been revealed that with linear perspective the observer may understand the image in view simply and logically, though anamorphic perspective may cause uncertainty and frustration before the view is comprehended. Through the combination of anamorphic perspective and trompe l'oeil, artists have achieved to mislead the mind to recognise certain objects or even entire scenes as purely realistic, leaving no doubt that their view is genuine.

The psychological effects of anamorphosis on one's perception were studied during the 20th century, though when they were finally clearly described they were apparently 'forgotten' in the archives. In museums of Natural History they are considered to be nothing more than 'diversions in the field of optics', and seem to be ignored because of their misconceive value. [10] Contemporary artists though, who have studied the old methods, continue to attain new levels of understanding and use of the illusory systems.

Despite the fact that anamorphosis and trompe l'oeil have been used for a few centuries, they still achieve to absorb and amuse spectators. Increasingly these systems are being incorporated in healthcare and office facilities to stimulate a sense of relaxation, significantly minimising stress levels.

I believe that the SkyCeiling™ system could be explored further in other fields, such as transport, especially in the Underground. As people usually spend a substantial amount of time travelling with the Underground, constantly having fluorescent lights above them, they seem to lose connection with the outside world and even sometimes experience claustrophobia. The illusory surfaces can be integrated into the ceilings as well as walls of the platforms and underground train

carriages, either as static images or video footage of sky, sea views, or even the traffic above.

In the modern world, the use of illusionism in architecture can play a significant role to control the appearance of spaces and structures. By the use of the 'diminishing course', facades can be created to seem much larger from the ground than in reality, by decreasing the relative size of the replicated sections towards the top, as well as in interior surfaces by diminishing and increasing the size of tiles, or even through the use of multi-patterned carpets. Illusions could also be used in rooms where satisfactory space could not be attained, thus giving the impression of expansion or connection to the exterior, especially in underground areas. It is conceivable that their use could also be beneficial in the field of restoration, where it would either be of great expense or difficulty to recreate architectural elements and details to a high degree.

By reintroducing these techniques of the past as standard practice in suitable situations, they can become very advantageous to clients and members of the public alike, to create pleasant environments, designed with mathematical precision, and thus establish architecture's firm link between art and science.

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